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PROJECT COMPLETION REPORT

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
(LOAN 2427-KO)

MAY 17, 1991

Population and Human Resources Division
Country Department II
Asia Regional Office

GLOSSARY

KAIST	=	Korea Advanced Institute of Science and Technology
KCUE	=	Korea Council for University Education
KEDI	=	Korea Education Development Institute
KNUTE	=	Korea National University of Teacher Education
KOSEF	=	Korea Science and Engineering Foundation
MOE	=	Ministry of Education
MOST	=	Ministry of Science and Technology
OSROK	=	Office of Supply, Republic of Korea
PCR	=	Project Completion Report
SEDC	=	Science Education Development Committee
STB	=	Science and Technology Bureau

THE WORLD BANK
Washington, D.C. 20433
U.S.A.

Office of Director-General
Operations Evaluation

May 17, 1991

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: Project Completion Report: KOREA - Program for Science and Technology Education - (Loan 2427-KO)

Attached, for information, is a copy of a report entitled "Project Completion Report: Korea - Program for Science and Technology Education (Loan 2427-KO)" prepared by the Asia Regional Office, with Part II of the report contributed by the Borrower. No audit of this project has been made by the Operations Evaluation Department at this time.

Attachment

PROJECT COMPLETION REPORT

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
(LOAN 2427-KO)

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PROJECT COMPLETION REPORT

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION (LOAN 2427-KO)

PREFACE

This is the Project Completion Report (PCR) for the Program for Science and Technology Education in Korea for which Loan 2427-KO in the amount of US$100.0 million was approved on May 29, 1984. The loan was closed on schedule on June 30, 1989. The last disbursement was made on January 9, 1990 and total disbursements were US$96.5 million or 96.5% of the loan amount.

The PCR was prepared by ASTPH (Preface, Evaluation Summary, Parts I and III) and the Borrower (Part II). The Borrower was requested to consolidate the separate reports of the three project institutions into one report but this was not done. The three separate reports therefore constitute Part II of the PCR. Parts I and III were submitted to the Borrower in September 1990 but no comments were received. The three reports constituting Part II were received in the Bank in December 1990.

Preparation of this PCR was started during a Bank mission in March 1989, and is based, inter alia, on the Staff Appraisal Report; the Loan Agreement; supervision and progress reports; correspondence between the Bank and the Borrower; and internal Bank memoranda.

PROJECT COMPLETION REPORT

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
(LOAN 2427-KO)

EVALUATION SUMMARY

Objectives

(i) The principal objective of the program was to assist in raising the quality of science and technology education to standards required for an industrial system that would be more skill-and knowledge-intensive and would employ more advanced technologies. The strategies for achieving this quality improvement objective include: expanding science and technology programs selectively; strengthening research; raising average standards of programs in science, engineering and science education at both undergraduate and graduate levels; and improving secondary-level science education with a more experiment-oriented curriculum. Major steps taken by the Government were: new and revised policies guiding the development of science and technological education, institutional changes for strengthening sector management and strengthening the financial position of some private institutions, a major source of higher level manpower supply (para. 4).

Implementation Experience

(ii) Despite the complicated nature of the project involving two ministries and many project institutions, and requiring significant policy and institutional improvements, the project was implemented satisfactorily. There were no cost or time overruns. The Government's education policy was strengthened and planned institution building was achieved. Guidelines and criteria were adhered to. Quantitative and qualitative targets were largely reached and in some cases, exceeded. The exception is the target student/faculty ratio of 20:1 which was not reached in 1989, but only reduced to 30:1 from 36:1 in the mid-eighties (para. 10 and Table 8 III (c)).

(iii) Possible delays in project implementation due to the complexity of the project, which were seen as a potential risk at appraisal, did not eventuate. This outcome was due largely to the early involvement of the borrower in project identification and preparation, the built-in flexibility for making changes after joint annual and mid-term reviews, the simplification of equipment procurement review procedures and the Government's strong commitment to the project objectives (para. 11).

(iv) Two unforeseen events affected project implementation. First, the Government reserved $5 million of loan proceeds for meeting possible deficits in equipment contracts caused by exchange rate fluctuations and the consequent need for additional payments in dollar terms in excess of amounts at time of

contract signing. The actual total deficit was less than anticipated and there was insufficient time to utilize the unused part of the reserve before loan closing. The unused amount therefore contributed to the cancellation of about $3.5 million or 3.5% of the loan. This was not a major setback but the unused amount could have been reduced and possibly eliminated if appropriate action had been taken such as allowing additional equipment purchases by MOE or permitting KOSEF to finance more research grants (para. 12(a)). Second, the initial enrollment of the newly established Korea National University of Teacher Education (KNUTE) fell behind planned figures due to an unexpectedly low demand for teacher education. However, remedial measures resulted in the enrollment target being met in 1989 (para. 12(b)).

Results

(v) The objectives of the project were largely met. Policy achievements were impressive: the shift of emphasis from quantitative expansion to quality improvement, improved manpower monitoring, use of accreditation for quality control, promotion of research, changes in college admission procedures, increased emphasis on experimentation, raising faculty qualifications and remuneration, concentration of resources for graduate education in key universities and increased financial assistance to private institutions (paras. 14 - 15 and Table 8). Institutional changes were equally impressive such as the accreditation work by the Korean Council for University Education (KCUE), establishment of the Science Education Development Committee (SEDC), and the Science and Technology Bureau (STB) within the Ministry of Education, the creation of a new teacher education institution to provide graduate programs (KNUTE), increased research responsibility at the Korean Science and Engineering Foundation (KOSEF) and the increased role of the Korea Advanced Institute of Science and Technology (KAIST), (para. 16).

(vi) The project has had a significant impact on education sector development, resulting in a better science and technology education subsector as a whole, improved practically-oriented science and technology education programs now also in many private institutions, a new college admissions procedure affecting attitudes towards learning in high schools and a stronger science education foundation among high school students (para. 17.

Sustainability

(vii) Improvements introduced under the project are likely to be sustainable. The major reason for the expected outcome is strong Government commitment as demonstrated in the many policy and institutional changes made during implementation. Other reasons include the adequacy of project design allowing for further developments and improvements, availability of government resources and institutional support. Experience and competence of local staff provide further assurance about future sustainability (para. 18).

Findings and Lessons Learned

(viii) Bank staff contributed towards project success through substantial assistance in project design and preparation. The flexible approach at both the project design and implementation stages also contributed to the project's

satisfactory outcomes. Both points should constitute positive lessons learned for the future. Other findings and lessons learned were:

- higher staff-week input at the upstream stage of the project cycle leads to lower staff-week requirements at the implementation stage.

- effect of exchange rate fluctuations must be closely monitored;

- a coordinator for the preparation of the Project Completion Report is needed for multi-ministerial projects;

- staff continuity, if feasible, would be useful for smooth implementation; and

- a Specifications Review Division should be highly productive for preventing and reducing procurement problems.

(paras. 19 to 22).

PROJECT COMPLETION REPORT

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION (LOAN 2427-KO)

PART I. PROJECT REVIEW FROM BANK'S PERSPECTIVE

A. Project Identity

- Project Name: Program for Science and Technology Education
- Loan No.: 2427-KO
- RVP Unit: Asia Region, Country Department II
- Country: Korea
- Sector: Education
- Subsector: Science and Technology

B. Project Background

1. Sector Development Objectives (At the time of project appraisal). In support of the Government's strategy for a planned transition from a labor-intensive industrial system to more skill-intensive, high technology production, the education sector's objectives were: to promote the technological development of Korean industry through an increased supply of higher quality scientific and technological manpower; improve science and technology education at both graduate and college levels; and strengthen the foundations of science and technology within society through improvement of science education at the secondary level.

2. Policy Context. In recognition of the need for placing more emphasis on quality improvement than on the increase in supply of trained personnel, the Government's education policy shifted to: (a) expansion of training capacity in selected fields only; (b) qualitative improvements through (i) stricter quality control, (ii) more emphasis on research, (iii) improving the supply and qualifications of faculty, (iv) resolving the shortage problem of facilities and equipment, and (v) raising the quality of new entrants at the admission stage; and (c) strengthening sector planning and broadening the financial base of private educational institutions.

3. Linkages Between Project, Sector and Macro Policy Objectives. The project was largely successful in linking project, sector and macro policy objectives (Part III). It succeeded generally in meeting the overall sector development objectives as set forth in para. 1 above and contributed towards the transition of industrial development to the stage of a more knowledge-intensive industry. This is supported by a recent series of science and technology advancement projects which have been assisted by the Bank. The policy goals set out in para. 2 above were also largely attained. The exception was that the goal of lowering student/teacher ratios had not been totally achieved, although the original goal may have been over-ambitious.

C. Project Objectives and Description

4. Project Objectives. The principal objective of the project was to assist in raising the quality of science and technology education to standards required for an industrial system that would be more skill- and knowledge-intensive and would employ more advanced technologies. The quality improvement objective translated into a strategy to: expand science and technology programs selectively, strengthen research, raise average standards of programs in science, engineering and science education at both college and graduate levels and improve secondary level science education with a more experiment-oriented curriculum. To implement this strategy, the government stated in a Policy Letter to the Bank that it would (a) introduce new and revised policies guiding the development of science and technology education; (b) effect institutional changes to strengthen sector management; and (c) improve the financial position of sector institutions by reducing the investment gap between public and private institutions. To effect its implementation, the Government proposed an Action Program with respect to planned policy and institutional changes and included a schedule for implementing the measures proposed. Amendments to Supplemental Letters in 1985 broadened the eligibility criteria to permit more science and technology institutions to benefit from the project, and increase the participation of private institutions.

5. Project Components. (as in Schedule 2 of the Loan Agreement). The project consists of financing for national programs and sub-projects in science and technology education to be carried out by eligible institutions as set forth in the following Parts: I. For the Ministry of Education: Part A - at the graduate training and research, and college levels; Part B - at the Secondary Level, and Part C - for Sector Planning and Finance; and II. For the Ministry of Science and Technology (MOST): Part D - expanding the programs, and strengthening the management of the Korea Science and Engineering Foundation (KOSEF); and Part E - strengthening graduate education at the Korea Advanced Institute of Science and Technology (KAIST), and improving collaboration among graduate schools and research institutes.

D. Project Design and Organization

6. The project was well designed and prepared, based as it was on several studies namely: the "Sector Survey of Science Education in Korea", IBRD Report No.3775-KO, January 1982, the "Study on the Development Plan of Korean Science Education" MOE Report, April 1982, and the "Proposed Plan for the Second IBRD Education Sector Loan," MOE submission to the Bank, August 1983. The timing was appropriate as it supported the ongoing transformation of Korean industry from an earlier, more labor-intensive stage, to a more

recommended contract awards, no irregularities in equipment procurement were found and the workload on bank staff had been reduced; policy changes were being carried out; agreed guidelines had been observed, and there were no major concerns on possible serious time and cost overruns. Under these circumstances, a second sector loan was felt to be justified. The operation was also justified because of the need to continue to strengthen the sector policy framework beyond Ln. 1800-KO.

8. There was an oversight at the time of appraisal for not having requested the Ministry of Finance to coordinate the task of preparing the Project Completion Report (PCR). The three major parts of the project were MOE, KAIST and KOSEF, the latter two being under the jurisdiction of the Ministry of Science and Technology (MOST). Therefore it was a cross-ministerial project. As one ministry had no authority over another, there was a need for a co-ordinator to oversee the preparation of the PCR. The absence of a co-ordinator led to three PCRs being produced, not one PCR as stipulated in the Loan Agreement. Furthermore, the timing of one of the three PCRs received by the Bank was six months behind schedule, and this caused delay in the preparation of Parts I and III of PCR in the Bank.

E. Project Implementation

9. Comparison of "Planned" versus "Actually Performed" in Project Implementation. A feature of this project was the unusually small difference between "Planned" and "Actually Performed" in project implementation, although the project was complicated (two ministries and two major agencies), the demand on the Government for policy and institutional changes was heavy and the guidelines and criteria contained in Sections 3.05 and 3.06 of the Loan Agreement were strict (see Supplemental Letter dated June 15, 1984 and its three annexes). The major difference was that the average student/faculty ratio of around 36:1 in science, engineering and science education departments was not reduced to the target ratio of 20:1. By 1989, the ratio had been lowered to about 30:1 (Table 8, p. 5) and this represents a solid achievement over five years. It is probable that the target ratio was over-ambitious but steady progress is continuing to be made in reducing the student/faculty ratio. As a whole, the project was implemented satisfactorily. (See Table 8 on Project Results and Part III Annex I on compliance with Planned Action Program). The Government's education policy was effected (para. 2 above); planned institutional building was achieved; guidelines and criteria were adhered to; quantitative and qualitative targets were largely reached and in some cases, exceeded; and there were no cost or time overruns.

10. Project Risks. The risk seen at appraisal was delayed implementation, because the project was complex to execute and would impose a significant management burden on Government. However, the project was implemented successfully without delay. This was largely due to three factors - the early involvement of the borrower in project identification and preparation, the built-in flexibility for making necessary changes after joint annual and mid-term reviews and the simplification of equipment procurement review procedures. These factors were reinforced by the Government's commitment to the project objectives as evidenced by the Policy Letter signed by the Minister of Education.

11. Unforseen Factors Affecting Project Implementation. There were two unforeseen factors which had some adverse effect on project implementation:

(a) Fluctuations in exchange rates during the implementation period, 1984-88, caused discrepancies between the estimated dollar equivalent of contracts signed in currencies other than US dollars and the actual payments in dollar equivalents. Theoretically, the errors should more or less have canceled each other out, as some estimated costs would be higher than the actual due to favorable changes in exchange rates, and some estimated costs would be lower than the actual due to unfavorable changes in exchange rates. Unfortunately, most of the MOE contracts were showing deficits versus original figures calculated on the basis of previous exchange rates. The Government therefore reserved $5 million of loan proceeds for the deficit and advised the Bank accordingly. However, by loan closing, the total deficit turned out to be only $2.7 million rather than $5.0 million and by that stage, there was insufficient time to utilize the unused amount of the reserve (about US$2.3 million). This amount was therefore undisbursed and cancelled and the borrower therefore did not benefit from the full disbursement of the loan. However, this problem was not significant enough to make the project unsuccessful, although it could have been avoided if remedial measures had been taken in time such as, using this amount for more equipment purchases by MOE or allowing KOSEF to use it for research grants; and

(b) The Korea National University of Teacher Education (KNUTE), established in 1985, suffered from lagging enrollments due to an unexpectedly low demand for teacher education caused by an unanticipated backlog of unemployed teachers. As a result, both the teaching staff and graduate school enrollment fell behind planned figures. The remedial measures taken by the Government to increase the number of applicants aimed to provide some incentives to the graduates from KNUTE in job placement, such as priority in assignment. The measures were expected to increase the competitiveness of KNUTE in comparison to the other graduate schools of teacher education and thereby increase the pool of qualified applicants by KNUTE. The remedial measures produced results. Since by 1989, the full enrollment capacity of 2,000 had been reached, one year behind the target date.

12. Actions or Decisions not Taken which Affected Project Implementation. There was some cancellation of the undisbursed loan at the time of closing (US$3.47 million) 1/ and this could have been avoided. The

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1/ The major cause was the $2.7 million not actually used within the $5.0 million reserved for exchange rate losses (para. 12(a)). KAIST also had about $0.1 million of its loan allocation canceled. The remaining (about $0.67 million or about 1% of the loan) was due to underspending of funds for technical assistance at MOE caused by the use of less costly local consultants instead of consultants from overseas.

Government could have allowed flexibility in the use of the loan proceeds by different project agencies by permitting the transfer of funds between the agencies. Had some fungibility been allowed in the use of loan proceeds, KOSEF could have used the amounts unspent by MOE and KAIST. The amount was not large (US$3.47 million), but overall disbursement performance would have been improved if the unspent loan funds had been utilized by KOSEF. To build in fungibility between agencies in the same ministry was difficult and even more so between ministries, given the existing strict internal auditing rules. However, by involving the auditors in advance, this problem might have been solved. Also, MOE could have notified participating project institutions of the availability of some funds as soon as the surplus was detected. Had these actions been taken, the unused amount would at least have been reduced and possibly eliminated.

F. Major Results of the Project. (refer to Part III Table 8 for Project Profile at Completion).

13. Project Objectives. The objectives of the project were largely met. Policy achievements were very satisfactory. Institutional developments were achieved as planned. Management development was generally satisfactory, strong in procurement of goods and services, but slightly behind in disbursement and the preparation of the project completion report. Quantitative targets were met or exceeded except in the student/teacher ratios in science and engineering colleges departments. Qualitative targets were also met or exceeded in terms of performance indicators, but the real judgement on quality improvements will come in the future from employers of the outputs of the science and technology education subsector and by the growth rate and the changing structure of Korean industry, to which, among other factors, scientists and engineers will make a major contribution.

14. Policy changes and institutional development. Policy changes and institutional development were achieved substantially as planned. Furthermore, although not explicitly contained within the Policy Letter, the policy on quantity and quality had changed. In the early eighties, through an over-generous annual admission quota, the supply of graduates was deliberately designed to exceed demand so as to retard the wage increase spiral. From the mid-eighties, the policy shifted to slower and more selective growth rates of enrollment quotas with emphasis on quality improvement. The change is a healthy development, and perhaps is due partly to the continuing dialogue between Government and Bank staff over recent years, in which Bank staff were consistently advising the Government to place emphasis on quality rather than on quantity. Supporting policies were improved manpower monitoring, use of accreditation for quality control, promotion of research, changes in college admission procedures, increased emphasis on experimentation in the curriculum, raising faculty qualifications and remuneration, concentration of resources for graduate education in key universities and increased financial assistance to private institutions.

15. To implement these supporting policies, existing institutions were given more assignments and new institutions were established to fill gaps. The Korean Council for University Education (KCUE) conducted accreditation work from September 1985 and submitted its first evaluation report one year

later. The Science Education Development Committee (SEDC) was established in September 1985 and a new Science and Technology Bureau (STB) was formed in MOE with two divisions, one for science education and one for vocational education. KNUTE was established in March 1985 and enrollments had reached the target of 2,000 in 1989. The role and responsibility of KOSEF had been expanded for promotion of more research in the fields of science and technology through increased research grants from government and endowments accompanied by better monitoring of research results. KAIST was assigned an increased role in producing doctorates and masters in science and engineering.

16. Impact of Project. The impact of the project on sector development is both broad and deep. This can be illustrated as follows:

(a) Korea now has a better science and technology education subsector. Faculty qualifications have been raised; their teaching load reduced; more research undertaken; equipment standards have been substantially raised; course work more experimentally oriented; and quality of entrants to both graduate and undergraduate courses improved;

(b) instead of offering more practically-oriented science and technology education only in national universities where the laboratories were better equipped, the quality of these programs in many private higher education institutions was also improved through financial assistance;

(c) the new college admissions procedure was implemented from the 1988 academic year with two major changes. Under the previous system, all students sat for the college admissions examination first and then submitted their applications to MOE indicating their priorities regarding universities. Success or failure of the student to be admitted into a higher education institution depended solely on the examination result. The universities were then allocated the students to be admitted without direct participation by the universities. Under the new procedures, the students apply first to the universities they wish to attend and then take the examination, thus reversing the previous procedure. The change is designed to enable universities to participate more directly with the students who are applying for admission. Furthermore, criteria for admission now include not only the examination result, but also high school scholastic and non-scholastic records and interviews. In the long term, the new procedure will assist in transforming secondary level education from rote learning for the purpose of passing the college admission exam only, into one with emphasis on in-class studies and out-of-class activities, practical work in laboratories and equal weight for all subjects taught irrespective of whether they were to be tested in the college admission examination. The pressure of over-studying and tutoring before examinations will also be reduced. The procedure will be further improved in 1993 through the introduction of aptitude tests and individual college examinations; and

(d) the foundation of science education was improved at the secondary level through higher equipment standards at 800 high schools, establishment of regional science centers, introduction of a more experimentally-oriented curriculum and retraining and upgrading science teachers and laboratory assistants.

G. Project Sustainability

17. Strong Government commitment to the improvements achieved under the project indicate that they will be sustained in the future. Moreover, this commitment is demonstrated more forcefully by the accomplishment of additional improvements not specifically required under the project such as: (a) reversal of the policy of rapid expansion of graduates in science and technology in favor of one of selective expansion and greater emphasis on quality improvement (para. 15); (b) additional changes in college entrance procedures to be completed by 1993 (para. 17); and (c) a general reform of the senior secondary school curriculum which is taking place between 1988 and 1992 (a fact revealed during the preparation of the proposed vocational education project). Other reasons supporting sustainability include: (a) the adequacy of the project design which allows for further developments and improvements, such as the use of KCUE for continuous evaluation, and the monitoring of science education developments and improvements by STB; (b) availability of government resources such as the phased increase of research grants for KOSEF from the Government budget to replace loan proceeds, and the continuing financial assistance to private institutions; and (c) institutional support from institutions such as SEDC and the Korea Educational Development Institute. The high degree of experience and competence of local staff provides further assurance of the sustainability of the project's accomplishments.

H. Bank's Performance During Project Cycle

18. Major Strengths and Weaknesses. Bank performance in relation to the project was in general satisfactory, particularly regarding preparation and appraisal which followed a Bank sector review of education in science and technology. The design of the project was complex and involved major policy issues and institution building objectives. Bank staff contributed towards its later success through, for example, substantial assistance in the preparation of the policy letter, action program, guidelines and criteria. Through lessons learned during the appraisal of the first sector loan (Loan 1800-KO), the appraisal team adopted a flexible approach to project design. For example, rather then relying on specific covenants to measure project outcomes (such as student/staff ratios), a number of appropriate indicators were included in the Action Plan and monitored during project supervision. This flexible approach was continued during implementation by allowing amendments to Supplemental Letters in response to emerging project needs (para. 4). A minor weakness related to the preparation of the project completion report. The Bank did not fully understand the difficulty of producing a project completion report from two ministries and three agencies. The problem was not detected early enough to: (a) remedy the problem of the lack of a coordinator, and (b) prevent the delay in producing the PCR.

19. Lessons Learned. The principal lessons learned or again confirmed from this project are as follows:

(a) A sector loan, if well prepared and appraised after sector work and efficiently implemented, could contribute significantly to achieving sector development objectives.

(b) Bank staff should be flexible in their approach to project design issues.

(c) Higher staff-week input at the upstream stage of the project cycle for more effective preparation and appraisal would lead to lower staff-week input for supervision during implementation period (Table 12 of Part III); another cause of the lower input for supervision could have been the waiving of the prior review requirement for procurement.

(d) For multi-ministerial projects, the Ministry of Finance should be requested to be the co-ordinator for the preparation of the PCR.

(e) Projects implemented during a period of wide exchange rate fluctuations should be closely monitored, particularly in the year before the Closing Date. This would help to ensure that loan funds which had been reserved to cover currency fluctuations but not utilized for this purpose, would be disbursed before loan closing, thus precluding the need for cancellation of loan proceeds.

(f) Table 12 shows that the total number of staff weeks in field is only 17.5 for ten supervision missions during the total implementation period of five years. For seventeen persons on supervision in the field, the average per person is only about one staff week. Due to the sector loan nature of this project, a large portion of the staff's time in the field was devoted to policy dialogue, annual review, mid-term review, ex-post review of procurement actions and sample checking of the full documentation for statements of expenditure used in connection with special accounts. The time left for visiting project institutions was therefore negligible. This leads to several outcomes, namely: (a) actual operations in the institutions concerned were not observed; (b) the views of the institutions regarding the project were not known, or at best, were gained second hand through the Ministry of Education; and (c) the views of employers at locations where the universities were sited and their graduates were employed also were not known. In view of the successful implementation of the project and its emphasis on policy and institutional improvements, the above outcomes do not necessarily reflect on the effectiveness of project supervision. However, useful insights could have been gained into the impact of the project from a sample of project institutions if additional time had been allocated to institutional visits during supervision missions.

I. Borrower's Performance During Project Cycle

20. Major Strengths and Weaknesses. With the experience of implementing five Bank/IDA loans and credits including one sector loan over 15 years, the borrower's performance throughout the project cycle from sector work to project completion was in general highly satisfactory. The procurement agency, the Office of Supply, Republic of Korea (OSROK), which had been strengthened through the addition of the Specifications Review Division in the Foreign Procurement Bureau, performed faultlessly on equipment procurement. Two minor weaknesses were: the preparation of three PCRs instead of a consolidated one and the cancellation of about 3% of the loan (para. 20(d) and (e)).

21. Lessons Learned. This project verified again the importance of continuity. Accumulated expertise over time was used despite many staff transfers. A national procurement agency has advantages over separate procurement offices in various ministries and agencies. The Specifications Review Division of OSROK, responsible for procedural reviews over and above the usual technical review, was a very useful innovation introduced by the Government. It serves as a preventive measure for possible procurement problems rather than a curative one.

J. Project Relationships

22. Impact of Relationships on Project Implementation. The relationship between the Bank and the ministries (MOE and MOST) continued to be cordial and this had a positive impact on the smooth implementation of the project. The relationships between the Bank and project institutions under MOE was, with few exceptions, remote since there were a large number of such institutions (e.g., 800 high schools). While MOE served well as the bridge between the Bank and project institutions, Bank staff did not visit a reasonable sample of project institutions during implementation, partly due to the lack of time allocated during supervision mission (para. 20(f)). Although there was no obvious problem caused by the lack of institutional visits, they would have broadened the Bank's understanding of the project's impact. The contact with industry by the bank during project implementation period was nil. Again, useful insights regarding the project's impact on the ultimate beneficiaries would have been gained from visits to employers. The relationship between KAIST and industry was excellent; 41% and 19% of KAIST graduates respectively with masters and doctorates went to work in industrial entities and this, in turn, proved the relevance of the training to industrial needs. KAIST also collaborated well with research institutes (one of the project objectives) which led to 27% and 42% of masters and doctoral graduates respectively joining research institutes after graduation. On the research promotion side, KOSEF maintained excellent relationships with the universities with practically all of its grants being awarded to professors.

K. Consulting Services

23. Role, Performance Level and Implications of Involvement. The consulting services component was less than 1% of the loan. However, at MOE, the contribution of local specialists was significant, e.g., ten study reports

were produced which were utilized in sectoral planning and in some cases, led to follow-up projects (Table 9). For KAIST, the actual use of specialists had exceeded planned figures--the total staff months for 93 experts were 53 versus the planned 50. KOSEF had employed only one overseas specialist, and had spent only about a quarter of the fund allocated on technical assistance ($400,000). This did not adversely affect KOSEF's work, because there was adequate local experience and competence available for reviewing research proposals and evaluating research papers.

L. Project Documentation and Data

24. Adequacy of Staff Appraisal Report, Major Working Papers and the Legal Agreement. Project documentation and data, including working papers relating to project preparation and appraisal, were adequate. The staff appraisal report was most useful for the Bank and the Borrower during implementation. The data relevant to the preparation of the PCR were readily available from the Bank, but not all relevant data were available from the borrower at the time for preparing the PCR (para. 8), although this problem was partly alleviated by the use of Bank data. A possible improvement to the Loan Agreement was that there could have been three "Unallocated" categories instead of one for the three major executing agencies (para. 9).

II. PROJECT REVIEW FROM BORROWER'S PERSPECTIVE
(By Ministry of Education, November 1990)

A. Project Summary

Objective of the Project

25. The basic objective of the science and technology education sector program (the 6th IBRD Education Loan Project: 2427-KO) was to improve the quality of science and technology education in Korea, in contribution to the country's scientific skill, knowledge and technological requirements in the 1980s and beyond. The sector program, preceded by the 5th IBRD Education Loan Project (1800-KO), included the policy and institutional changes and selective investments, designed to selectively increase the graduate level education in science and engineering fields; strengthen the research capability of graduate level education; improve the overall quality of the undergraduate curriculum in the field of science end science education; and increase science class hours in the secondary schools so as to introduce a science curriculum with emphasis on laboratory work. The components included: (a) control the quality of graduate and college level education; (b) concentrate graduate education in a few key institutions; (c) strengthen an institution for research funding and promotion; (d) improve collaboration between academic institutions and research institutes; (e) establish an institution for advanced training and research and development in science education; (f) adjust the college admissions procedures to reward student achievement in school, including performance in laboratory-based assignments; (g) introduce new secondary science courses with a greater emphasis on practical work; (h) strengthen monitoring and evaluation procedures; (i) recruit and upgrade teaching staff and (j) improve facilities and equipment.

26. The $100 million loan was to be equivalent to 14% of the total estimated investment program for science and technology of $711 million. The overall program, of which a part was financed under the present loan, comprised five national programs including accreditation assistance, research grants, staff development, equipment for secondary schools and regional science centers, and analytic studies, and about 60 subprojects for equipment requirements of specific graduate schools and colleges. $78 million was appropriated for the MOE-supervised projects.

27. At the graduate and college levels, by 1990, student/faculty ratio was to average 20:1; average teaching load was to be approximately 10 hours per week; about 50% of all faculty were to be on full time appointments; and the proportion of faculty holding a doctorate was to reach 65% in science, and 50% in science education and in engineering. The shortage of laboratory facilities was to be reduced to 15% of the official standard. At the secondary level, all students in general high schools were to study four science subjects; 140 experimental units were to be introduced in these courses; about 20% of instructional time in science was to be devoted to experimental science; and the overall deficit in laboratory facilities and science equipment was to be narrowed to about 15% each. By 1990 the science and technology education sector was to graduate approximately 7,000 students per year at the graduate level in science or engineering: 18,000 students at

the college level in science education; and 480,000 students per year from general high schools with an improved science curriculum. As a result of these programs, these graduates would be of higher quality and work in the fields of evident national priority.

Plans for Improvement of Facilities and Equipment

28. Rigidity in the Laboratory Facilities Standard for Colleges and Universities has been considered to be an obstacle to the Expansion Plan. To eliminate the obstacle, government undertook a task to revise the Standard List of Laboratory and Practice Equipment for each department and completed a study on Optimum Standard Lists of Laboratory and Practice Equipment for College Education in April, 1986.

29. Based on the Lists, the minimum standard for laboratory facilities of national and private institutions was upgraded by Notification 87-4 of MOE on February 12, 1987. Standards for research facilities of graduate program are not determined at the moment, but reports from studies on improvement plan have been submitted. The improvement of the research facilities of graduate schools essential to a development of high-quality science and technology manpower would be reviewed here extensively.

Current Status of Research Facilities in Science and Technology

30. Laboratory experiments for undergraduate science students are essential to acquire the practical knowledge and the equipment are essential for that purpose. So far, education loans have provided most of the funds for the purchase of equipment in higher education in Korea.

31. Approximately $370 million have been invested for the purchase of equipment, of which half are spent on natural sciences (23% of total) and engineering (27% of total) combined. Quantity of the equipment installed under the loan project amounts to 67,600 pieces to make the availability ratio less than 50% of MOE's facilities standard.

32. This ratio is somewhat higher for national and public institutions than for private institutions. Considering the durability of the equipment, those purchased under the education loan project before 1980 should be worn out and replaced by now. Availability of equipment in research laboratories and graduate research facilities is 26% and 76% respectively, far below the standard. A bold investment plan is necessary for acquisition of research laboratories. Acquisition of equipment has depended largely on foreign loans, but continuous funding from domestic sources is to be requested in the future.

Development of Research Facilities in Graduate Education

33. The graduate education improvement project is being promoted with emphasis on the demand and supply of the research facilities by 1991 based on the 6th 5-year Econo-Social Development Plan of Korea. Budgetary needs per faculty for procurement, installation, and maintenance of research equipments were estimated to be $115,000. One of the recommendations for the development of graduate education is selection of the field for an intensive support of

graduate-oriented institutions. Basic research institutions of the fields are recommended. The estimated budgetary demand in the areas of the advanced science and technology is approximately $700 million. It was analyzed that the project could be achieved most effectively by selective and concentrated investment to the university affiliate research center.

Standardized Inventory Management System of Education Facilities

34. As prerequisite for the improvement of advanced science and technology, basic scientific experiments and workshop education should be carried out faithfully at undergraduate level as well as the vigorous and specialized research activities of faculties at the graduate level.

35. Among the many impediments towards the goal are definitive shortages in the required laboratory equipment and failure to manage the effective operation. In order to solve the problems, it is desirable for the public (national) colleges to take the standardized inventory management system, which is currently adopted as an effective measure in the government offices, and establish the standard lists of experiments and inventory of the laboratory equipment within the limit of practical realization. They should also take action to insure the funding necessary to acquire the standard inventories reflected in the governmental revenue. Once the standardized inventory systems are adopted by the national institutions, they can be elastically appropriated to the private institutions as well.

36. The Study used the following criteria to decide the standardized inventory of the laboratory equipment: all the items in college experimental laboratory facility standard notified by MOE were taken as the objectives, and the necessary quantity of the equipment was calculated on the assumption that the one laboratory class unit was 30 students.

37. Questionnaires formulated according to the criteria were sent to the selective sample institutions. A standardized inventory was drafted from each department in science and engineering. Since research facilities and equipment are characteristically diversified and specialized, standardization is considered to be unreasonable. Accordingly, financing for the research equipment should be decided after reviewing the individual research capability of the faculty member. Instead of the standardization, whether the equipment is utilized effectively to the research goal should be reviewed and managed closely. These measures would insure the savings of public funds and maximize the research capability to educate the high-quality science and technology manpower.

Joint Utilization Plan of Educational Facilities

38. Problems brought about from the acquisition and utilization of the research equipment are increasing since the current advanced science require highly precise research equipment. High price of the research equipment puts the pressure on the revenues for equipment purchase. Also the level of precision of the equipment makes maintenance and operation extremely difficult, not within the reach of individual researcher.

39. Therefore, the establishment of the center for joint utilization of the research facilities is not only the solution essential to overcome the lack of economic capability and management skill of the researchers, but also the catalyst in modernizing the science administration system in equipment maintenance and operation. Selection of the emphasized-financing field following the establishment of the center for joint utilization in the form of research institute would provide an important opportunity to decide the short- and long-term direction for the national scientific development policy in the future.

40. Formulas for the centers may not be necessarily uniform, but could be diversified to meet the nation's reality. In the report, the regional centers for facility utilization that accommodate a variety of equipment for joint utilization were reviewed, regardless of the formulas of the center and the field of emphasized-financing. Characteristic, establishment method, and management plan for each regional center were reviewed and data from the exemplary centers would be used as basic materials for the future policy development.

Mid- and Long-term Acquisition Plan for Research Facilities

41. Since Korea's investment in research facilities has been realized with the intermittent foreign-based education loans to date, purchase of the many equipment items was seldom made with continuous long-term planning.

42. Due to the characteristics of the loan, the implementation procedure was so complex and the supplementary expenses were so high that minimum 2-3 years were required from the time of item selection to the acquisition, resulting that, in some cases, equipments already turned old-fashioned were purchased with unjustifiably high price. Therefore, the acquisition of facilities in the colleges should be made with domestic public revenue with continuous long- and mid-term planning.

43. Astronomical amounts of resources would be required to upgrade the research and educational facilities of all the colleges to the level of international quality standard. Viewing the limitation of the national financing resources, it is hardly recommended to support all the colleges evenly. Accordingly, financing for the facilities acquisition should be carried out selectively to utilize the limited national funds to the maximum efficiency.

44. In order to establish the criteria for selection of the support institution and the extent of financing, colleges were categorized into three groups according to their educational goal: (1) institutions with emphasis on undergraduate education, (2) institutions with emphasis on undergraduate education, with some degree of graduate education and research capability, and (3) institutions with emphasis on the graduate education and research. The financial support was made to improve the education quality of group (1) institutions to the level of developed countries and to increase, cumulatively, the number of group (2) and (3) institutions. Under the strategy to increase the number of group (3) institutions to 20-30% of total to meet the social demand by the year 2000, the minimum necessary revenue is

estimated to be 30 billion won in 1990 and 420 billion won in 2000. This amount is enough assuming that the revenue for facilities acquisition is 20% of the total investment for all the colleges. In addition, practice of joint utilization of the expensive research equipments would improve the quality of the science education.

Monitoring System for School Science Education

45. In order to evaluate science achievement in both primary and secondary school education and analyze the educational environment to prepare the basic materials for the development plan of science education, Science Education Development Committee on the request of MOE implemented annual studies on "Development of Improvement Plan and Education" from March 1986 to December 1988. In the summary report, the study team constructed "Models for Status Survey and Establishment of Development Plan" and "Instrument developed for the Evaluation and Survey of Science Education." With these models and instruments they made a concrete investigation into the analysis of science achievement and the conditions for science education. In the category of the analysis of science achievement are included knowledge, inquiry skills, basic experimental technique and skills, and attitudes toward science.

46. In the conditions for science education are included high school science instruction, instructional conditions and materials, college entrance examination system, R&D in science education and science teacher training, administration, finances, supervision and text compilations.

47. The study report is well conceived, includes valuable information resulting from a thorough survey, and provides important advice. The government takes it seriously and considers all the recommendations of the report. Following is the summary of the report. Four research objectives were formulated for the study of science education conducted for the first time in Korea.

(a) To prepare national assessment framework and basis of curriculum improvement through formulation of goals and objectives of science education.

(b) To prepare standards and criteria of supporting system in science education for the planning of science education policy, administration and finance.

(c) To identify problems of science education based on nationwide status survey and comprehensive analysis of the survey data.

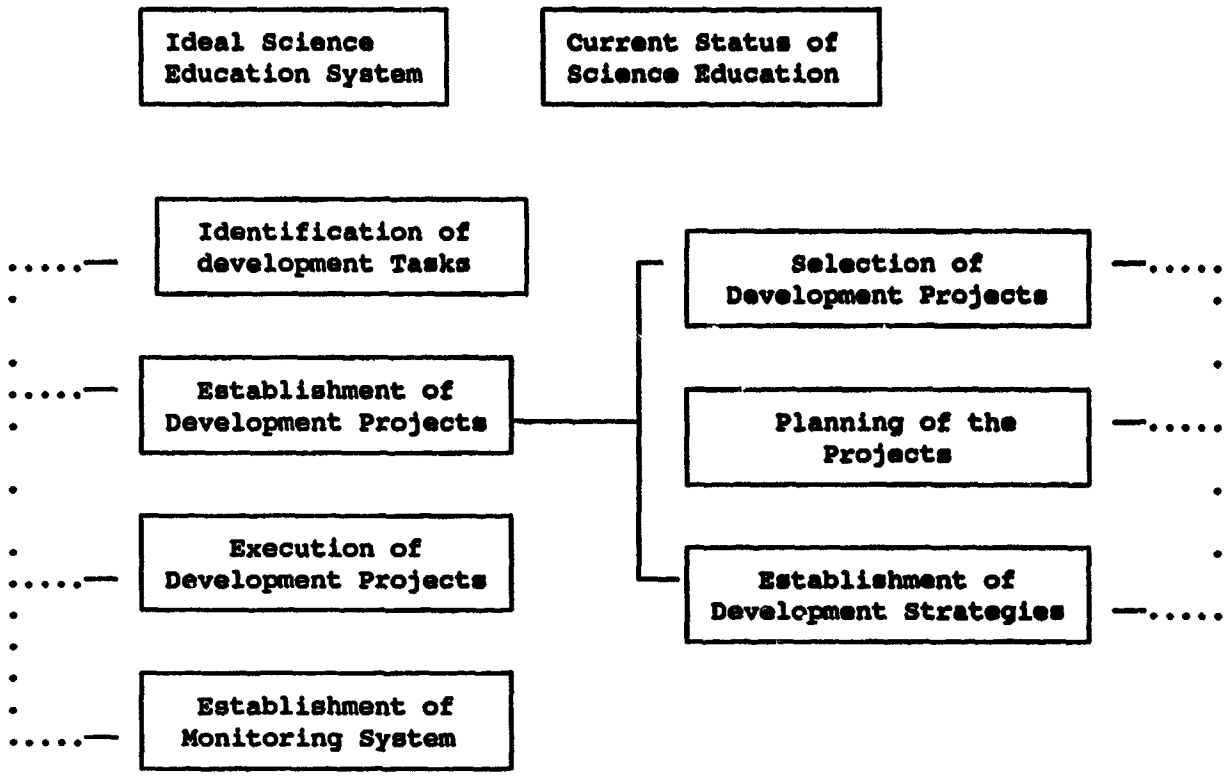
(d) Suggestion for improvement plan and monitoring system of science education.

48. A model for the establishment of development plans and monitoring system was developed as shown below. According to the model, development task is identified from the gap between the ideal science education system and the current status of science education. The development procedures, which include selection of development projects and their planning and execution

strategies, are established to iron out the gap. Outcomes of the project execution would be evaluated by the monitoring system and would give a constructive feedback into the prior steps .

49. A plan for improvement of science education should be conceived as a long term plan and schemed in a way to keep pace with the societal development of the nation. It has its ultimate goal at science learning achievement of students. Toward this goal, it requires to achieve improvement in the instructional conditions, teacher development, school facilities, outside assistance, support, equipment, teaching assistants, and supporting materials. Following eight development tasks are identified and corresponding projects are established in the report: Reform of the science education and establishment of supervising system; R & D and International Research Activities in Science Education; Support of Institutions for Training Science Education Professionals; Upgrading Qualities and Enhancement Morale of Personnel in Science Education; Promotion of General Conditions for Science Instructions; Support of Environment beneficial to Science Education; Promotion of Related Enterprises; and Establishment of Assessment Systems for Science Education.

50. Studies on the evaluation and environment of high school science education were conducted using the instruments developed for that purpose. These will be used as base materials for future studies and policies on the development of science education.



Recruitment and Upgrading of Teaching Staff

Current Status of College Faculties in the Field of Science and Technology

51. The teaching staff in the colleges of natural sciences and engineering and at the departments of science education in colleges of education were projected to more than double from 6,040 in 1983 to 14,730 by 1990 in the IBRD Staff Appraisal Report on the 2nd Sector Loan Project (para. 2.07, Table 2-1). The criteria for recruitment of new teaching staff at that time were that such increase was required for achieving student : teacher ratio of 20:1. Estimated according to the Statistical Yearbook of Education, the number of faculty is approximately 10,895 as of 1989. The slight increase in the number of faculty indicates a considerable effort in the faculty recruitment. But still the figure is short of approaching 14,000, the project goal of the year 1991. The total number of students in natural sciences and engineering is 401,227 which makes the estimation of student : teacher ratio to 37:1. This ratio is far short of 20:1 which is the project goal of the year 1990. But the number would be considerably improved to 30:1 if only the project institutions are considered exclusively. The ratio is 18:1 for science education only. It is fortunate that other educational environment in nationwide colleges (universities) have been considerably improved. The weekly teaching load had decreased to about 11 hours by 1987 and the percentage of full-time faculty in all the teaching responsibilities is improved to 54%.

Academic Degrees Held by the Faculty

52. The proportion of faculty with doctorate degree as of 1989 is 77% in natural sciences, 76% in engineering, nd 75% in college of education. These figures, corresponding to increase of 30% from 1984, far exceed the project goal (65% for natural sciences and 50% for engineering, showing a gradual improvement of staff quality. But for the teachers' college, most of the faculties are holding masters degree.

Teacher in General High Schools

53. In-training of the teaching staff in colleges of natural sciences and engineering and secondary education is as important as curriculum development. One of the main goals of the 2427-KO Loan Project is the faculty development. A major evaluation criteria for faculty development is the number of publications, which has been increasing markedly over the time period of five years. The number of research publications and participating faculty increased by 50% and 37% respectively. Total research fund is estimated to be 11,000 million won, increased by about 2.5 fold.

Procurement of Educational Facilities

Current Status of Educational Facilities in Colleges

54. Acquisition of laboratory facilities and workshop equipments are prerequisites to the improvement of science and technology education. The number and size of laboratories improved a bit, but are still far short of the goal. The number meets only 74% and size 66% of the requirement. Continuous investment in laboratory facilities is essential to the quality improvement of science and technology education in the future.

55. For most institutions, the availability did not improve considerably. This is because the college laboratory facilities and equipment standard were upgraded in February 1987 under the improvement plan for facilities and equipment. The standard for some private colleges was not altered, so that availability ratio improved by approximately 5-10% from that in 1984. But installation of the new equipment procured by the 6th IBRD education loan markedly improved the utilization rate, which was verified during the on-the-spot survey.

Scientific Equipment of General High Schools

56. Availability ratio of laboratory facilities is over 80% to the requirement. The degree of improvement quantity-wise increased considerably for the five-year span. On the other hand, it increased only 45% amount-wise. This indicates that the goal achievement approached only in quantity with low-quality equipment and not enough usable items have been acquired. More investment in the secondary technical schools as well as general high schools is essential to form a firm foundation of the quality improvement in science and technology education.

Acquisition Plan for Laboratory Facilities in Graduate School

57. Factors for quality improvement of graduate education in science and technology included upgrading of staff qualifications, policy of graduate education, and acquisition of research facilities. Among them, it is the shortage of research facilities that is most in need of improvement. Although the urgently needed basic equipment is considered to have been acquired from the 6th Education Loan, there is still much to be improved. More investment for graduate-oriented research facilities, particularly in the basic and high-tech science fields (such as new materials, semi-conductor, and genetic engineering) should be preceded before Korea's industries are upgraded into the pace of developed countries. Until recently Korea depended heavily on the foreign loan for funds necessary to purchase scientific equipment (IBRD education loan supplied 71% of the revenue source in public (national) institutions and 49% in private schools for purchase of equipment and facilities over the time period 1984-1989), and the trend is expected to continue for some time. It would be advisable to give the policy consideration to allocate at least more than 10% of public loan to education sector considering the effect of science and technology education on the development of the information-oriented industrialized society.

Effect of the Project on Science Education Policies

Development of Science Education Policies

58. Science and technology will play an important role in exploiting the nation's industrial structure. That requires major investments and policy development in scientific and technological infrastructure and in manpower development. Direct investment has been made to purchase laboratory equipment at undergraduate and graduate programs in science and technology, science education in the colleges of education, science high schools, and general high schools. Additionally, nine research projects have been implemented for the development of science education policies. The outcomes will be conducive to the future education sector plans.

Improvement of Graduate Education and Faculty Development

59. Laboratory equipment that has been procured under the loan projects are very conducive to the graduate education and faculty research activities. The number of publications has been increasing remarkably for the period of the 6th IBRD Education Sector Loan Project, indicating that faculty research is improving in substance. The number of faculty holding a doctorate degree increased appreciably and overseas training programs have also contributed considerably to the improvement of staff qualifications.

Training System of High-Quality Manpower in Science and Technology

60. Plans for strengthening manpower development in science and technology should be determined in accordance with the demand of industries, research institutes, and educational institutions. For that purpose, plans for establishment of training system for the high-quality manpower in advanced science and technology have been studied. Under the plans, graduate education

is improving substantially during the period of 6th IBRD Education Sector Loan Project and the number of graduate students working for higher academic degrees are increasing gradually.

Status Analysis and Improvement Policy of School Science Education

61. As a prerequisite for overall quality improvement of science education in primary and secondary schools, problems and impediments have been apprehended through the status analysis. As a result, urgent problems and important projects requiring long-term investment were brought up concretely. They will form foundations for the development of science education policy to upgrade the national standard of science in the 21st century.

Performance of Government Responsibilities

62. At the time of Loan Agreement, the Korean Government prepared an Action Program in Sector Policies and Institutional Development to improve the quality of education programs in science and technology.

Graduate Training and Research

Undergraduate and Graduate Program Accreditation in Science and Engineering

63. Government requested Korean Council of University Education (KCUE), an association of 311 colleges and universities in Korea, to conduct reviews and evaluation of undergraduate and graduate programs in order to establish a proper educational goal and quality control of the educational system accreditation. Accreditation was conducted for 1 year beginning September 16, 1985. Models by department for conduct of accreditation and questionnaires for accreditation were developed. Accreditation reports were submitted on September 15, 1986 after computerized analysis of the collected information.

Graduate-oriented Programs in Science and Engineering

64. In order to improve the quality of graduate programs in science and engineering, a few selected institutions would be assisted intensively. Individual characteristics of the project institutions would be reflected on the expansion plan for facilities and equipment. Towards this goal, the Government was to prepare a long-term development plan as a prerequisite for the selection of graduate-oriented universities. A professional study team was organized in December 1984. A report on long-term development plan of graduate programs in science and engineering (371 pages of text and 41 pages of annex) was prepared in July, 1985 and the recommendations have been reflected on the government policies.

Graduate Programs and Research Development in Science Education

65. Government established the Korea National University of Teacher Education (KNUTE) and started to admit the students in March, 1985 to improve the quality of science education by strengthening the graduate programs in science education. In the first year of operation, the University planned to enroll about 1,500 students yearly including about 700 at the graduate level.

Of these, approximately 250 were to pursue the masters and doctorate degree in science education. As of May, 1989, 1,963 students are enrolled in undergraduate program of KNUTE.

66. At the moment, 137 (out of 247 quota) are enrolled in the master's program and 49 (out of 84 quota) are enrolled in the doctorate program which started operation in March 1986. The graduate programs and research development in science education have not been as well underway at the moment as would be desired. To meet the triple goal of research, teacher education, and re-training of teachers, the KNUTE should make every endeavor to recruit more students in the graduate programs.

Science Education at Undergraduate Level

Improvement of the Present Conditions for College Education

67. The Government had prepared faculty development and faculty recruitment plans for colleges of education, colleges of natural science and colleges of engineering and implemented plans according to the following goals for 1990 : average student : teacher ratio would fall to 20:1 : average teaching load would be 10 hours per week; at least 50% of faculty would be on full-time appointments; and the proportion of faculty with doctorate degree would be 65% in colleges of natural science and 50% in college of education and colleges of engineering.

68. As of 1989, according to the Statistical Yearbook of Education, the average student : teacher ratio is 23:1 for colleges of natural science and 51:1 for engineering, indicating large difference between natural science and engineering. When we take only the project institutions into account, the student : teacher ratio is 32:1 in the colleges of natural sciences, 33:1 in the colleges of engineering, and 18:1 in the colleges of education (28:1 in the national colleges of natural sciences). These numbers are considerably approaching the project goal.

69. Fortunately, other educational conditions of all the colleges and universities have been improved : average teaching load is about 11 hours per week; 69% of faculty are on full-time appointments. The proportion of faculty with doctorate is 76% for national universities in natural sciences and 80% in engineering which is higher than the overall average 56%.

Preparation of an Improvement Plan for Facilities and Equipment

70. Government had prepared the revised equipment lists by subject area in order to solve the problems indicated from the improvement plan for facilities and equipment : the rigid facilities guidelines, inexperience in the usage of the facilities, shortage of accessories and parts, and selection of the equipment requiring a high maintenance cost.

71. The study team, organized in November 1985, initiated a study on the proper standard for laboratory facilities and experimental equipment at college level and drew up a tentative guideline (7 areas) an April 30, 1986. Equipment for colleges of education is primarily for science education and

science teaching. Approximately 30 colleges of natural science and 20 colleges of education were to be assisted under the program.

72. The shortages in laboratory facilities were to be reduced to about 15%. The shortages in equipment for teaching and research would be reduced to about 30% by 1990. Laboratory work was to increase from 10% to about 30% of class time.

Secondary Science Education

73. Government had adopted a plan to increase the study of science subjects, particularly at the high school level; to improve curricula and instructional materials; to strengthen the skills of classroom teachers; and to upgrade facilities and equipment of general high schools and regional science centers. Its concrete achievement goals were the creation of the Science Education Development Committee (SEDC), staff strengthening of the Science Education Division (SED) of the Science and Technology Education Bureau (STEB), study on the improvement of science education, improvement of college admission procedures, and staff development for secondary science teachers and laboratory assistants. Actions taken under the program up to now are listed below.

Creation of SEDC

74. SEDC was to be organized by June 30, 1984 in order to establish an agency to oversee the design and implementation of the new science curriculum with greater emphasis on experimental and practical science work. Towards this goal, the Government created SEDC with 8 members on September, 5, 1985. Its function was to advise on the implementation of the 6th IBRD Education Loan Project in short terms as well as on the long-term science education policy making and implementation. The past performances are listed below:

Feb. 5, 1986	Discussion of programming of research and development project for 1986.
July 25, 1986	Evaluation of status analysis and development of science education at high schools.
Sept. 23, 1986	Discussion to improve ways for development of basic science education projects in the 6th 5-year plan.
March, 1987	Discussion on ways for overseas training of secondary science educators.
June 1, 1987	Promotion of a study on the establishment of the status analysis, development, and monitoring system of secondary science education.
April 30, 1988	Promotion of a study on the establishment of the statu system of science education at school.

Staff Improvement of Science Education Division

75. In order to implement the disparate functions of curriculum design, material preparation, teacher retraining, and evaluation and feedback, the staff of the SED of GEB was set to increase to 15 by June 30, 1984. Toward this goal the Ministry of Education was reorganized and divisions involved in the administration for science education were enlarged on August 25, 1986. Namely, Science and Technology Education Bureau was newly established in the reorganization and Science & Technology Education Division was divided into Vocational Education Division and Science Education Division. The staff was increased to 16 staff with addition of 7. Contents of increase were 1 division director, 2 assistant directors, 1 senior researcher of Education, and 3 other general staff.

Improvement of College Admission Procedure

76. Government was to introduce, by June 30, a plan for monitoring the secondary science program and a plan for improving teachers' assessment skills. Government requested SEDC as its first assignment to analyze actual conditions for high school science education and study ways of development and establishing new system to check related progress (March, 1986). A project completion report was completed on December 16, 1986. Contents of the study were: examining rationale of science education and itemizing purposes thereof, developing criteria and apparatus for evaluation of learning achievement; grasping problems and searching ways for development. Integrated reports from the studies on science education for secondary level (Dec. 30, 1987) and elementary school (Dec. 26, 1988) were published.

Improvement of College Admission Procedure

77. In order to establish a basis for improvement of science education, the Government had a plan to adjust college admissions procedure to enable individual colleges to select students by taking account of student's overall performance on the entrance examination, as well as achievement on the science and mathematics component of the entrance examination and on the school record. Since 1981 college admission procedures have taken into account the school record. In most cases, however, only a total score is made available to colleges and decisions on admission are made without detailed information of student's prior achievement in science and mathematics. Government evaluated the entrance examination system and developed a modified approach with a view to providing selecting colleges the students' scores in mathematics and science as well as the students' school record. Findings of the study were planned to be implemented in the admissions cycle for the 1987 academic year.

78. A new college admission procedure was implemented from the 1988 school year. The biggest change was a change in system to application-- prior-to- examination procedure. Examination factors were sum of the written test results, high school records (to share 39% or more in the total credit), and interview credit. Each school is in charge of the admission procedure. Preparation of the examination is supervised by National Institute of Educational Evaluation. Examination subjects are same as before (9 subjects)

but subjective style examination should be taken at around 30% of the total credit. According to the nature of departments, each institution may designate selective subject and distribute additional points among subjects within 10% of the total credit. During the present education loan implementation period, the government is planning to establish the newly improved college admission procedure by December 1989, in consultation with the KCUE, so that the college admission system would contribute basically to the development of the secondary level education. The new college admission system, which would be operative from 1993 school year, includes the evaluation through the college aptitude test, high school performance records, and examination given by individual college. The aptitude test would be given twice a year by which the students' capability to obtain the college education would be evaluated. The allotment of the high school performance records would be increased to more than 40% of the total credit. Each college would be responsible for its own specific entrance examination, but the number of subjects tested would be limited to no more than two. The improved admission procedure, properly managed, would be a sufficient incentive for schools, teachers, and students to place more emphasis on science.

Staff Development for Secondary Science Teachers and Laboratory Assistants

79. Government planned to prepare a national program for retraining and upgrading secondary science teachers and specialists and recruit approximately 700 additional science teachers per year and attain a level of 2 laboratory assistants per general high school (project implementation April, 1984 - April, 1989). The number of science teachers was increased by 2,417 and laboratory assistants were reinforced by 517. The rate of reinforcement for teachers in natural sciences was 44%, slightly higher than 40% increase for overall subjects. Eleven fold increase in the number of laboratory assistant would be expected to be of great help to the laboratory management.

Problems of the Implementation Procedure

80. Problems in the implementation of the present loan project are derived from the complexity of the implementation procedure. It takes about two years from Loan allocation to equipment installation. Often the most modern equipment at the time of request for purchase becomes old-fashioned left out of progress in science and technology. Price increase and the changes in foreign exchange rate in the midst of the project implementation may bring about the decrease in the quantity of the equipment from original plan. It takes about two months from receipt of shipping documents to delivery of the shipping due to the complicated procedures between the project institutions, the MOE, and OSROK.

81. Since the application forms for IBRD Education Loan Project were too complicated and voluminous compared to the forms for other loan, it took lots of time and manpower for the preparation of the application form.

82. There are too many sorts of paper required for customs clearance of the equipment imported under the loan, which are, in detail, import declaration, supply notice of import goods, shipping documents, recommendation for tax reduction, confirmation on goods to be imported, confirmation on use

of goods imported, registration card of tax-exempted imported goods, and copy of business license and etc. A large scale reduction of such papers is recommended.

Problems in Equipment Installation and Utilization

83. Problems in equipment selection and utilization indicated in the 5th IBRD Loan Project have been improved somewhat in the present loan project. Feasibility of the research project was reviewed in the process of subproject evaluation. Installation cost (5% of equipment purchase) was provided, though not in sufficient amount. However, a few problems in the equipment utilization are yet to be improved:

(a) due to changes in price and the foreign exchange rate in the midst of project implementation, purchase of accessories and parts were not sufficient or equipment was replaced with those of lower quality.

(b) expensive equipments that could have been used jointly were purchased in duplication and equipment, that required a large sum of operating cost, were selected.

(c) the most grave problem in usage of equipment is lack of maintenance expenses and operation technicians. It is worse in the case of high-priced and sophisticated equipment. As there is no quota of operation technicians, graduate students or research assistants are in general doing the job. But lack of continuity and professionalism prevent the full utilization of the equipment.

Problems Due to the Changes in Foreign Exchange Rate

84. Many equipment contracts were signed in currencies other than US dollars. The US dollar equivalent of these contracts was therefore different at the time of contract signing and the time of actual payment because of the fluctuation in exchange rate of currencies.

85. Recently, most changes were not in favor of the US dollar. To make up the excess over-disbursement, the loan reallocation plans were discussed. The consequence was that the sum total of actual payments would exceed the original amount at the time of contract signing by about US $2.73 million.

Problems in the Implementation of the Government Covenants

Improvement in student : teacher ratio

86. Student : ratio was set to average 20:1 by 1990 as an achievement goal, but this goal seems to be far beyond practical reach. According to the educational statistical yearbook, the ratio is 38:1 for colleges of natural sciences and 46:1 for engineering.

Integrity of Korea National University of Teacher Education

87. The University, which opened in 1985, is unique in adapting an integrated approach to pre-service teaching, research and in-service training activities. The University is to be a model institution with the prime aim of improving the quality of teaching in Korea. However, the University has not been able to recruit all the required teaching staff and the graduate school enrollment did not reach the full quota. Although, it made a policy, as a remedial measure, to improve the quality of applicants at the undergraduate level and to treat the graduate favorably in job placement, the prospect is not very bright due to the societal factors such as the backlog of unemployed teachers.

Utilization of the Various Studies for the Improvement of Science Education

88. Variety of studies have been implemented as a part of education sector plan over the time period of the present loan project. They are: a study on long-term development plan of graduate level education in natural sciences and engineering, a study on the planning analysis and monitoring system of the teacher evaluation in science education, and etc. Recommendations suggested from these studies have yet to be utilized. In other words, the time and method by which they are adopted would decide the future direction of the science and technology education.

Enforcement of Financing to Private Institutions

89. It is one of the most urgent issues that Government set a plan to strengthen the financial base of private educational institutions and support them to meet their goals to improve the quality of education in Korea. Due to the lack of public support, there was a financing gap of about 40% of total spending on education and training in Korea. Hence, investment for faculty recruitment, acquisition of research and experimental equipment, and books and facilities are too scarce for the educational conditions to be improved desirably. Since the share of private institutions in science and technology education is about 75%, without a definitive plan for financing to private institutions, the improvement of the quality of science education in Korea would be greatly retarded. Financing to private institutions is meager in the present loan project. It is in the public interest that Government adopts measures to improve the financial base of private educational institutions.

Recommendations

90. Following problems have been identified during project implementation:

(a) Prolongation of the implementation period due to the complexity of the implementation procedure.

(b) Fairness in the international competitive bidding and difficulties in regulating specification of the equipments.

(c) Limitation in utilization of equipment owing to the lack of both equipment operator and repairing cost.

(d) Problems in equipment procurement due to the foreign exchange rate fluctuation.

(e) Problems concerning the quality control of the substituted Korean-made equipments and unjustifiably strict facilities and equipments.

(f) Substantiality of Korean National University of Teacher Education.

(g) Limited financial support to private institutions.

91. Some of the above problems were improved compared to the period of the 5th project implementation period. For others, continuous policy consideration and new investment should be followed on.

92. Although the project objective have not all been reached, it is a fair judgment that many projects have been implemented on schedule. Entering into the society of advanced industrial structure and information of the year 2000, Korea's demand in high-quality research manpower in science and technology is expected to grow. For improvement in effective science and technology education, following points related to this project should be emphasized.

(a) The quantitative growth of higher education may have been receptive to the growing national level of education and the national aspiration for higher education, but it failed to meet the societal demand of quality manpower and might lead to waste of social and individual resources. The long-term purpose of higher education should be, therefore, aimed at quality education and at supply of high-quality manpower to meet the demand of society.

(b) Graduate-oriented universities should be supported to strengthen graduate education for creative academic activities. Educational investment should be made to expand both the graduate research facilities and the research professorship program for upgrading R & D capability at graduate programs and to support university affiliated research institutes.

(c) For widening the manpower pool in science and technology, substantial development of education in basic science and technology should be promoted beginning with the relevant curricula of elementary and secondary education.

(d) For enrollment policy, it is desirable to curtail enrollments at the undergraduate level, thus reducing the output and alleviating the employment problem, but to expand graduate education, especially the Ph.D. programs. The expenditures saved from smaller undergraduate enrollment might meet the required funding for the expansion of the graduate level education.

PROJECT REVIEW FROM BORROWER'S PERSPECTIVE
(By Korea Advance Institute of Science and Technology, November 1990)

1. The Role of the KAIST in the Korean National Educational and Economic Development Plan

93. Korea's economic development and social progress during the last three decades have been called remarkable and well-known. Since 1960, Korea has developed from one of the poorest countries to a middle income, newly industrializing country. Impressive social gains have been made. Health, education housing and public services have improved significantly.

94. The remarkable feature of Korea's economic development is the fact that its human resources in favorable social and political environment enabled the country to make the impressive achievement in virtual absence of exploitable natural resources. Human resources consists of quantitative and qualitative aspects. Investment in education is the principal source of improving the qualitative aspect of human resources, namely, human capital. Since population growth has slowed down during the last three decades while education standards improved, the main source of Korea's economic development has been the improvement of its human capital through investment in education and health.

95. Education is expected to continue to play a pivotal role in Korea's economic growth in 1980's. However, it has to undergo structural change in line with the structural change occurring in the economy. Due to shifting comparative advantage and growing international protectionism, structural change and export diversification are thought to be necessary for Korea's sustained rapid economic growth in 1980's. New exports in skill-intensive and high technology fields must be vigorously developed. For this purpose, the technological capability of Korean industry needs to be upgraded. This in turn requires an increase in the numbers and an improvement in the quality of trained scientists, engineers and technicians by emphasizing the science and technical education, in particular, at a higher level.

96. In the past, education in Korea emphasized widespread provision of basic education and vocational training. This emphasis recorded an impressive achievement and significantly contributed to the country's economic growth. Korea's achievement in this field is unique among developing countries in that almost 100 percent of labor force is literate and 90 percent of production workers have completed secondary or primary education.

97. Having succeeded in the propagation of basic education, Korea is moving toward a system of mass participation in college education, estimated at 31 percent of the corresponding age-group by 1981. As the pinnacle of a developed education system, graduate education provides the trained faculty and serves to set and maintain standards at the college level.

98. If Korea is to achieve the planned structural change to more skill-intensive and high technology production, however emphasis should shift from college education to graduate education in science and technology.

99. The Korea Advanced Institute of Science and Technology (KAIST) could make a significant contribution to the advancement of graduate education in science and technology as a unique graduate education and research center for scientists and engineers. The KAIST was unique in two respects. First, it was the only institute in Korea designed solely for graduate education and research in science and technology. Second, it included a research institute formerly the Korea Institute of Science and Technology, within the system of graduate education. It is believed that the most effective method of training scientists and engineers of high caliber is to have a setting where education and research reinforce each other for the advancement of science and for the training of scientists and engineers.

100. The close cooperation in research and training has been established in KAIST, which is newly reorganized in 1981 by merging KAIS, a graduate education institute, with KIST, a research institute. As a graduate training institute, it not only enables a group of the most highly qualified researchers in Korea to train good researchers but it also provides a stimulus to scientists at KAIST to keep their topics on the frontier of their disciplines and timely in terms of Korean national needs. Although it covers only a limited range of academic and professional fields in science and engineering, KAIST has demonstrated its capacity to produce capable scientists and engineers. Its graduates have moved into academic employment as university faculty as well as industrial and research organizations.

101. If KAIST is to play a critical role in this time of transition of Korean economy from labor-intensive to more skill-intensive and high technology production, a greater degree of emphasis should be placed on doctorate and post-doctoral program than in the past.

102. The three tiers approach to the graduate programs of KAIST, e.g. , the regular master's program, professional engineers program and doctorate program are augmented by the post-doctoral program. The post-doctoral program consists of two parts. One is to provide educational and research periods at KAIST for those who have completed doctoral courses of study at Korean universities and abroad. Another is to send KAIST faculty abroad for professional contacts with their counterparts in advanced countries so that they may be kept informed of the latest advances in their disciplines.

2. Objectives of the Loan Application

103. KAIST's main objective in seeking an IBRD loan of US$10,000,000 was to improve and expand the existing and additional Ph.D. program, to institute a new post-doctoral program and to refresh the research and educational skill of its faculty. The funds were sought (1) to send the faculty abroad to keep them in touch with the frontier of knowledge in their disciplines in advanced countries, (2) to provide the foreign exchanges required to entice Korean Ph.Ds abroad to come to KAIST as post-doctoral fellows, (3) to recruit new faculty from Korean scientists and engineers residing in advanced countries, (4) to purchase research and teaching equipment for new departments and new faculty, and finally (5) to purchase foreign books and journals for the library. Addition of the Department of Applied Mathematics to the College of Science and that of Department of Civil Engineering to the College of

Engineering had already been approved. All new faculty members joining KAIST were provided with US$20,000 each for purchase of equipment for each new member's laboratory.

104. KAIST recognized that an educational and research institute was as good as the caliber of its faculty and research staff.

105. At this time of rapidly expanding technology and scientific knowledge, it was essential that KAIST enable its faculty to be in constant touch with the frontier of knowledge in their respective disciplines. For this purpose, KAIST sought to send every member of its faculty to institutes of learning and research in advanced countries in four or five year intervals. In the past, if a faculty member could not secure a paid position abroad, he had been unable to go to the institute of his choice due to financial constraint. KAIST sought to remedy this situation by the funds obtained through the IBRD loan.

106. KAIST considered research skill and experiments as an integral part of all graduate education and, in particular, Ph.D. education.

107. The teaching arm of KAIST, formerly KAIS had acquired a US$11,600,000 loan from the U.S. Export-Import Bank in 1978. The loan had mainly been used to purchase U.S. made equipment to implement the establishment of masters of engineering program. KAIST needed to upgrade and expand further equipment and facilities required to improve and expand its existing and additional Ph.D. program.

108. As the institute which offered graduate education and included a prestigious research institute within its educational system, KAIST was the only institute which could offer post-doctoral training to scientists and engineers. KAIST's post-doctoral program would recruit fellows from within Korea and Koreans abroad. The IBRD loan was sought to provide foreign exchange to enable KAIST to recruit promising Korean Ph.Ds abroad successfully.

109. The post-doctoral program, enabled them to know their homeland at a professional level. This played a significant role in attracting Korean scientists and engineers to Korean universities and research institutes. KAIST hoped to play a leading role in reversing Korea's brain drain by means of its post-doctoral program.

110. At the same time, KAIST planned to use a part of the IBRD loan to actively recruit Korean scientists and engineers in advanced countries for its faculty positions. An effective recruitment program contributed significantly to improving the caliber of KAIST's faculty.

3. Effect of the Project

111. KAIST has established an education program for producing about 4,000 doctorate degree holders in advanced science & technology by the year 2,000, as part of the government's "Science & Technology Manpower Cultivation Plan".

112. Execution of the education program for the IBRD Loan (2427-KO) Project resulted in reinforcement of the necessary educational/training equipment, and modernization of test equipment for supporting basic & sophisticated research, which will serve as a cornerstone for the science-oriented society in the future.

113. In particular, more than 640 kinds of educational equipment were purchased during the Project period, and more than 90 professors benefitted from overseas research & study sabbaticals based upon the IBRD Loan, which also enabled the Project to make a great contribution to the substantial development of the institute, especially in the educational area.

114. The effects of this IBRD Loan project (2427-KO) can be summarized as below.

- Establishment of a continuous in-house education system for the elite in science and technology, in order to achieve an advanced industrial society.

- Contribution to industrial development by transferring R & D results and technology, obtained through reinforcement of research capabilities, to high-level applied science & technology, as well as improvement in the research level of basic science.

- Establishment of the institute as a world-class graduate school in science & engineering, thus able to play a central role in reinforcing the bases for advanced science and technology.

TABLE 1: STUDENTS' REGISTRATION RECORD & PLAN

(Unit: Person)

Class \ Year		'83-'85	'86	'87	'88	'89	'90	'91	'92	'93
Master's Program	Regular students	1,289	483	487	515	512	750	800	850	900
	Research Students	551	48	41	33	41	50	50	50	50
	Sub-total	1,840	531	528	548	553	800	850	900	950
Doctorate Programs	Regular Student	463	187	230	239	250	300	300	400	400
	Research Student	176	84	66	76	80	80	80	80	80
	Sub-total	639	271	296	315	330	380	380	480	480
	Total	2,479	802	824	863	883	1,180	1,230	1,380	1,430

* The years 1990 and thereafter represent future plans

TABLE 2: STUDENTS' GRADUATION RECORD & PLAN

(Unit: Person)

Class \ Year		'83-'85	'86	'87	'88	'89	'90	'91	'92	'93
Master's Program	Regular students	1,387	351	430	464	457	500	497	727	776
	Research Students	13	197	103	48	50	39	31	39	47
	Sub-total	1,400	548	533	512	507	539	528	766	823
Doctorate Programs	Regular Student	156	55	99	104	105	150	184	191	200
	Research Student	8	17	22	29	30	57	84	66	76
	Sub-total	164	72	121	133	135	207	268	257	276
	Total	1,564	620	654	645	642	746	796	1,023	1,099

* The years 1990 and thereafter represent future plans

TABLE 3: NUMBER OF PROFESSORS AND RECORD OF THESIS PUBLICATION, BY YEAR

(Unit: Person, Thesis: Title)

Year		'81	'82	'83	'84	'85	'86	'87	'88	Total
No of Professors		83	90	103	117	136	143	150	158	-
Theses Published	Domestic	129	131	149	163	200	193	212	266	1,443
	Overseas	110	113	192	183	274	292	318	335	1,817
	Total	239	244	341	346	474	485	530	601	3,260

TABLE 4: NUMBER OF STUDENTS & FUTURE PLANS

(Unit: Person)

Class \ Year		'86	'87	'88	'89	'90	'91	'92
Master's Program	Regular students	915	949	995	1,041	1,276	1,564	1,664
	Research Students	220	153	123	114	123	140	149
	Sub-total	1,135	1,112	1,118	1,155	1,399	1,704	1,813
Doctorate Programs	Regular Student	579	684	790	933	1,049	1,116	1,277
	Research Student	312	372	438	493	548	560	590
	Sub-total	891	1,056	1,288	1,426	1,594	1,676	1,867
Total		2,026	2,168	2,346	2,581	2,993	3,380	3,680
No of Prof.		143	150	158	191	230	282	307
Students: Prof.		14:1	14:1	15:1	13:1	13:1	12:1	12:1

* The years 1990 and thereafter represent future plans.

TABLE 5: GRADUATING STUDENTS' EMPLOYMENT RECORD, BY YEAR

o Masters

(Unit: Person)

Agency \Year	'75-'83	'84	'85	'86	'87	'88	Total	%
Education Institute	345	18	10	2	7	6	388	8.1
Research Institute	638	20	210	203	127	88	1,286	26.9
Government Agency	110	11	9	9	4	6	149	3.1
Industrial Entity	685	267	238	190	223	235	1,938	40.5
Doctorate Course	289	95	137	144	172	177	1,014	21.2
Others	8	1	-	-	-	-	9	0.2
Total	2,075	412	604	548	533	512	4,784	100

o Doctors

(Unit: Person)

Agency \Year	'75-'83	'84	'85	'86	'87	'88	Total	%
Education Institute	45	16	31	24	33	50	199	36
Research Institute	31	20	24	38	71	38	232	42
Government Agency	13	1	1	-	-	-	15	2.7
Industrial Entity	21	6	8	10	17	42	104	18.8
Others	-		-	-	-	3	3	0.5
Total	110	43	64	72	121	133	553	100

TABLE 6: RESEARCH CONTRACTS, AND ASSOCIATE FUNDS, BY YEAR

(Unit:W1,000 ( ):Research case)

Year	Special Research	Entrusted Research	Basic Research	Sub-total
'72-'81	-	1,457,386 (282)	914,420 (443)	2,371,806 (725)
'82	428,496 (4)	651,050 (87)	252,714 (84)	1,332,260 (175)
'83	1,100,698 (8)	651,415 (77)	161,250 (85)	1,913,363 (175)
'84	1,764,754 (19)	1,300,142 (79)	271,800 (96)	3,336,696 (194)
'85	1,470,268 (29)	1,447,792 (91)	340,900 (124)	3,258,960 (244)
'86	2,699,328 (51)	1,741,761 (114)	548,452 (128)	4,989,541 (293)
'87	2,945,383 (86)	1,827,576 (105)	596,000 (129)	5,368,959 (320)
'88	3,440,485 (93)	2,163,494 (108)	611,000 (139)	6,214,979 (340)
Total	13,849,412 (290)	11,240,619 (943)	3,696,536 (1,228)	28,786,564 (2,461)

PROJECT REVIEW FROM BORROWER'S PERSPECTIVE
(By Korea Science and Engineering Foundation, November 1990)

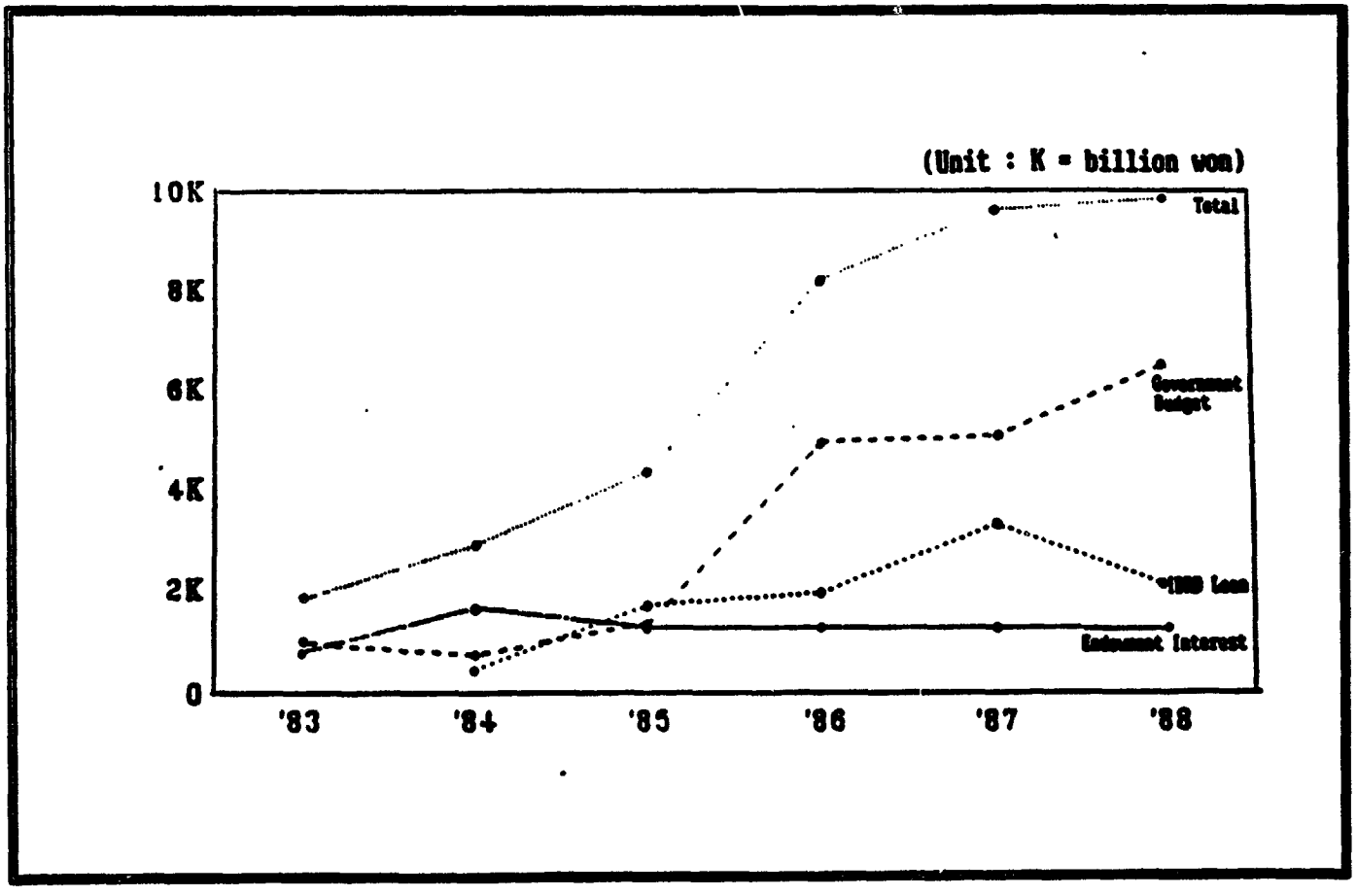
I. Project Evaluation

115. Through this program, KOSEF was to promote scientific and technological development capability in Korea by cultivating higher quality scientific and technological manpower hoping to bring it to the same level of advanced countries, a level deemed indispensable to economic and industrial development from a long-range perspective. KOSEF's total research support funds for FY88 amounted to 9,840 million won (equivalent to 14 million dollars) or only 4.2% of total research funds for all universities reaching 232,800 million won (or 333 million dollars).

116. For this reason, it was hard to expect to fulfill all needs of the academic and research communities. Nevertheless, KOSEF has had a positive impact on the academic communities of Korea. Because KOSEF's funds for FY83 amounting to 1,811 million won increased as much as five times to 9,840 million won for FY 1988.

ANNUAL RESEARCH BUDGET

Figure 1



TABLE

	'83	'84	85	'86	'87	'88
Endowment Interest	811	1,659	1,275	1,276	1,264	1,250
Government Budget	1,000	740	1,374	4,950	5,050	6,500
IBRD Loan	-	464	1,713	1,967	3,286	2,090
Total	1,811	2,863	4,362	8,193	9,612	9,840

117. This enabled us to double the number of grantees from 5% in 1983 to 1014 in 1988. In selecting research proposals, major emphasis was placed on the researchers' performance in the past, their potential research capability and the projects' significance, with the target of maximizing qualitative improvements in research. The expectation was that research assistance could encourage them to consider scientific questions and help contribute to the improvement of their academic research capability in their professional fields. Also, it aimed at cultivating creative researchers by providing graduate students with more opportunities to engage in positive research activities. Analysis of the results of our research support showed that 3 graduates have taken part in a research project and published 2 research papers in professional academic journals.

118. During the loan project implementation from '84 through '88, KOSEF provided 5,441 research projects with a total grant of 36,681 million won. Twenty six percent of that amount was provided by IBRD loans. The figure was quite far from the original plan to keep the portion of the IBRD loan share at 10 % of research support. IBRD loans, however, have served greatly as a catalyst in increasing KOSEF funding for research support. Total research funds for FY88 amounting to 9,840 million won have increased to 17,575 million won for FY 1989, showing nearly a 100 % increase over 1988.

Conclusion

119. The successful implementation of KOSEF's research program was made possible through a rigorous Peer Review System in considering research proposals, high quality advice and consultation in 15 priority fields provided by Members of Program Development and Review Committee and KOSEF's excellent administrative support. The effects of the loan project are as follow:

- On a national level, it helped greatly produce world famous scientists and strengthen their scientific and technological research capability by encouraging them to present their research results in international conference.

- Increased research funds have facilitated the research management capability of universities.

- With the increased government's interest in the research activities of universities, KOSEF's research funds were greatly increased.

- In an effort to improve the research management capability of KOSEF, it has increased the staff of 25 in 1984 to 101 in 1990.

PART III: STATISTICAL INFORMATION

A. RELATED BANK LOANS

Table 1. IBRD/IDA LOANS/CREDITS RELEVANT TO THE PROJECT

Loan/Credit Number Project Title	Year of Approval	Purpose of Project	Status	Comments
Cr 151-KO First Education Project	1969	Expansion of vocational high schools, junior technical colleges and teacher training.	Completed 9/76	Successful project and satisfactorily implemented.
Ln 906/Cr 394-KO Second Education Project	1973	Improvement of vocational high schools, junior technical colleges and science, engineering and education colleges.	Completed 12/79	Implemented substantially as planned. Line management evolved from Project Implementation Unit.
Ln 1906-KO Third Education Project	1975	Expansion and quality improvement in vocational high schools, junior colleges and vocational training institutes. (VTIS)	Completed 11/81	Successfully implemented with growing experience and competence of local staff.
Ln 1474 Vocational Training Project	1977	Further expansion of VTIs, and expansion and improvement of instructor training.	Completed 06/83	PCR concluded that the project was well designed, implemented efficiently and judged it to be an excellent example of Bank/Borrower cooperation.

Loan/Credit Number Project Title	Year of Approval	Purpose of Project	Status	Comments
Ln 1800-KO Sector Program on Higher Technical Education	1980	Improving junior technical colleges and colleges of engineering and management through supply of equipment, staff development, manpower planning, equipment maintenance and academic accreditation.	Completed 02/86	A sector program successfully implemented.
Ln 3037-KO Technology Advancement Prfoject	1989	Enhancing the capacity of two research institutions to provide technical support to small and medium industries and export certification on quality and improving the quality of science and engineering education at one key university.	Effective on 08/10/89	Being implemented
Ln 3202-KO Second Technology Advancement Project	1990	Improving the research capacity of one leading graduate school in science and engineering and enhancing R and D capacities in the areas of biotechnology, basic and industrial standards, and energy and resource utilization.	Effective on 11/08/90	Being implemented
Ln 3203-KO	1990	Enhancing basic research	Effective	Being implemented

Loan/Credit Number Project Title	Year of Approval	Purpose of Project	Status	Comments
Universities Science and Technology Research Project		programs in selected universities in priority fields in science and technology and improving science teacher training.	on 11/08/90	

B. PROJECT TIMETABLE

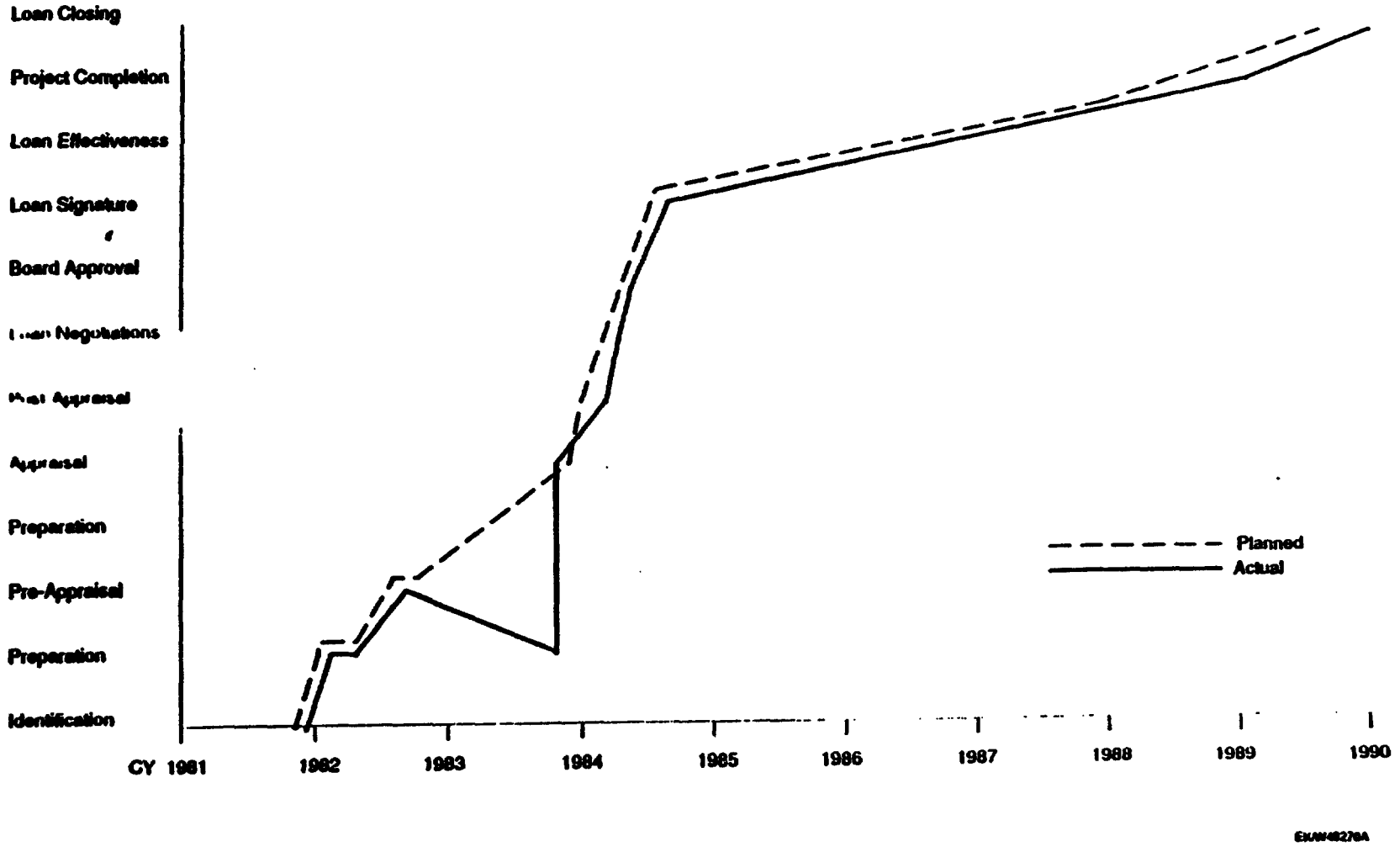
Table 2: PLANNED, REVISED AND ACTUAL DATES OF PROJECT TIMETABLE

ITEM	PLANNED	REVISED	ACTUAL
Identification Mission	November 1981	-	November 1981
Preparation by Government	Dec. 1981 to Feb. 1982	-	Dec. 1981 to Feb. 1982
Pre-Appraisal Mission	March/April 1982	-	March/April 1982
Preparation Mission	-	-	June/July 1983
Appraisal Mission	October 1983	September 1983	September 1983
Post-Appraisal Mission	January 1984	February 1984	February 1984
Loan Negotiations	April 1984	-	April 1984
Board Approval	May 1984	-	May 1984
Loan Signature	June 1984	-	June 1984
Loan Effectiveness	September 1984	-	September 1984
Project Completion	June 1988	-	June 1989
Loan Closing	June 1989	-	January 1990 /a

Comments: The Government had second thoughts on project size and loan amount after pre-appraisal mission and this caused delays and required further preparation after pre-appraisal.

/a Date of closing of the loan account (Jan. 9, 1990), although the loan was closed on schedule on June 30, 1989.

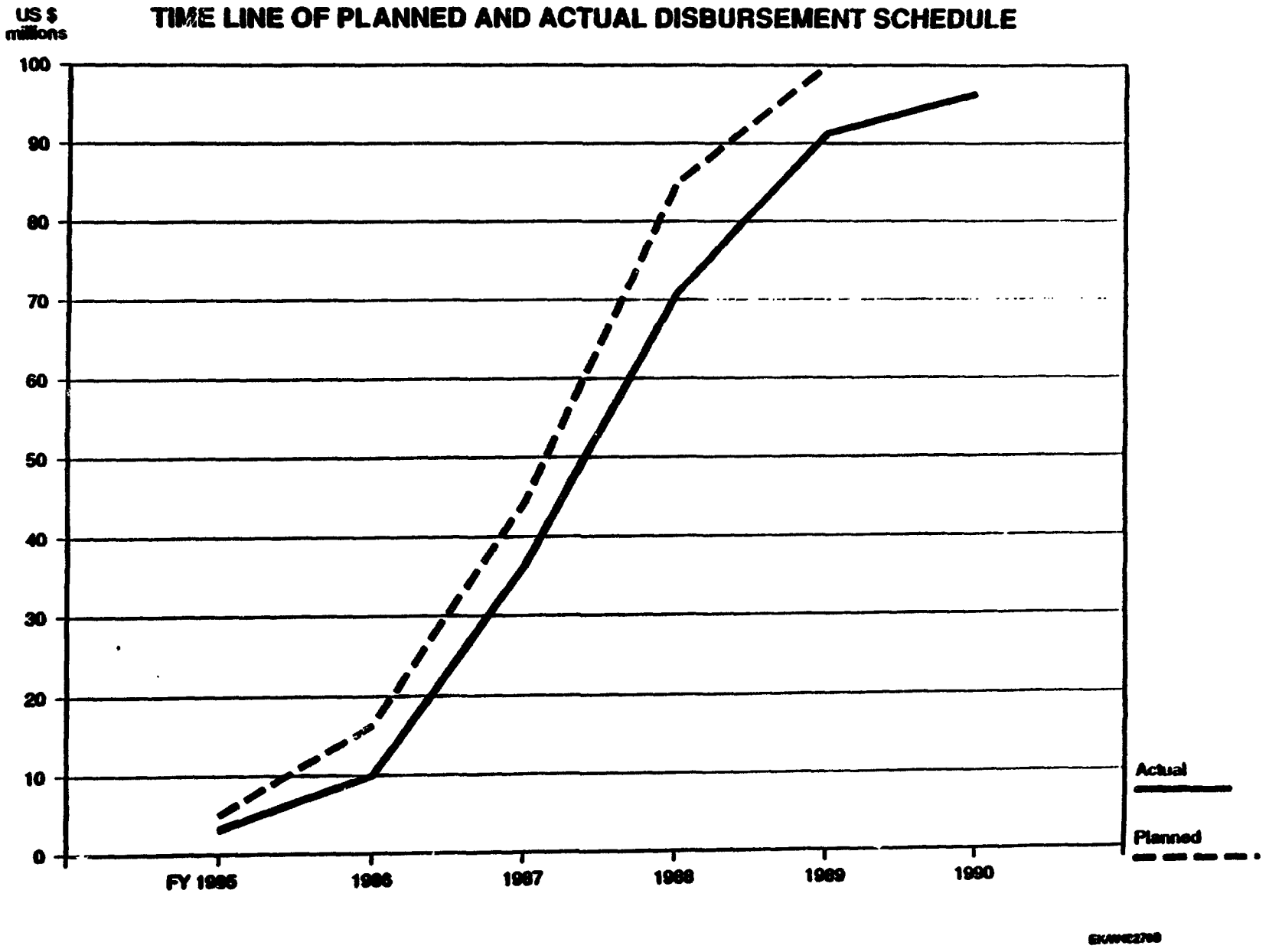
TIME LINE OF PLANNED AND ACTUAL PROJECT TIMETABLE



C. Loan Disbursements

Table 3: CUMULATIVE ESTIMATED AND ACTUAL DISBURSEMENTS

Bank FY	1985	1986	1987	1988	1989	1990
Appraisal Estimates	5.0	16.5	44.5	85.0	100.0	-
Actual	3.2	10.0	36.4	70.9	91.4	96.5
Actual as % of Estimate	64	61	82	83	91	97
Date of Final Disbursement						01/09/90


US $ millions
TIME LINE OF PLANNED AND ACTUAL DISBURSEMENT SCHEDULE
100
90
80
70
60
50
40
30
20
10
0
FY 1986
1988
1987
1988
1989
1990
Actual
Planned

D. PROJECT IMPLEMENTATION

Table 4: PLANNED AND ACTUAL COMPLETION DATES OF COMPONENTS [a]

Project Components	Planned Completion Date [b]	Actual Completion Date	Months of delay (or advance)	Percentage differences (- for advance)
Ministry of Education (MOE)				
Instructional equipment, books and materials	March, 1988	June, 1989	15	33%
Specialists' services	June, 1987	March, 1989	21	58%
Fellowships	June, 1988	December, 1989	18	38%
Repatriation of scholars	June, 1988	June, 1988	-	-
Studies	June, 1987	March, 1989	21	58%
Korea Science and Engineering Foundation (KOSEF)				
Specialists' service	June, 1988	November, 1986	(19)	-40%
Fellowships	December, 1987	September, 1987	(3)	-7%
Research grants	June, 1989	March, 1989	(3)	-5%
Korea Advanced Institute of Science and Technology (KAIST)				
Instructional equipment, books and materials	March, 1988	June, 1989	15	33%
Specialists' services	June, 1988	October, 1989	16	33%
Fellowships	December, 1987	June, 1989	18	43%
Repatriation of scholars	September, 1987	June, 1989	21	54%

[a] There was no extension of Closing Date for this loan.

[b] As taken from Schedule of Implementation, Annex 13 Chart 1 of SAR (Report No. 4891-KO) dated May 1, 1984.

E. PROGRAM COSTS AND FINANCING

Table 5: INVESTMENT PROGRAM COSTS
(US$ million)

Component	Appraisal Estimate			Actual Costs /a		
	Local Costs	Foreign Costs	Total	Local Costs	Foreign Costs	Total
MOE	295.7	296.8	592.5	80.5	74.4	154.9
KOSEF	20.3	30.6	50.9	n.a. /b	12.0	12.0
KAIST	30.0	21.7	51.7	n.a. /b	9.9	9.9
Total	346.0	349.1	695.1	80.5	96.3	176.8

/a Actual costs were inaccurate due to inadequate information from KOSEF and KAIST and incomplete information from MOE (see Note for Table 6)

/b Not available from reports submitted by KOSEF and KAIST.

Table 6: PROJECT FINANCING
(US$ million)

Source of Funds	Planned (as in Staff Appraisal Report)	Revised	Final
IBRD Expenditure Categories			
MOE	78.0	77.8	74.4
KOSEF	12.0	12.0	12.0
KAIST	10.0	10.0	9.9
sub-total	100.0	99.8 [b]	96.3 [c]
Domestic			
MOE from Government	347.5	-	59.1 [d]
from private sector	167.3	-	21.4 [d]
sub-total	514.8	-	80.5
KOSEF from Government	38.9	-	n.a.
KAIST from Government	41.6	-	n.a.
sub-total, domestic	595.3	-	80.5
TOTAL	695.3 [a]	-	176.8

[a] Includes $0.2 million Front-end fee

[b] After deducting Front-end fee and rounded.

[c] Adding $0.2 million Front-end fee, this becomes the total amount of loan fund disbursed ($96.5 million).

[d] Government funds diffused in various budgeting categories could not be extracted out accurately for investment program costings. This applies to private sector, too.

n.a. Not available from Reports submitted by KOSEF and KAIST.

Table 7: ALLOCATION OF LOAN PROCEEDS

	Original Allocation	Actual Disbursements	
Ministry of Education (MOE)			
(1) Instructional equipment, books and materials	60,000,000	68,689,424.16	
(2) Consultants' services, fellowships, studies and repatriation costs	10,000,000	5,763,371.83	
(3) Initial deposit in the MOE Special Account	1,000,000	0.00	a
Korea Science and Engineering Foundation (KOSEF)			
(4) Consultants' services and fellowships	400,000	73,358.30	
(5) Research grants	9,700,00	11,896,715.70	
(6) Initial deposit in the KOSEF Special Account	1,000,000	0.00	a
Korea Advanced Institute of Science and Technology (KAIST)			
(7) Instructional equipment, books and materials	6,200,000	7,244,355.00	
(8) Consultants' services, fellowships and repatriation costs	2,700,000	2,611,764.63	
(9) Initial deposit in the KAIST Special Account	300,000	0.00	a
Other			
(10) Front-end fee	249,377	249,377.00	
(11) Unallocated	7,750,623	0.00	
TOTAL	100,000,000	96,528,366.62	
Amount of loan cancelled		3,471,633.38	

[a] The three negative residual amounts, -19,913.92 in Category 3, -3,634.16 in Category 6 and -407.66 in Category 9, were absorbed into categories (1), (5) and (7) respectively. The residual amount, if negative, is a gain for the Borrower, and this is caused by exchange rate fluctuations, (see memorandum dated February 5, 1990 from Mr. H.K. Phung).

F. PROJECT RESULTS

Table 8(a): DIRECT BENEFITS OF PROJECT

I. Expand Selectively Graduate Education:

Area	Number of Applying Graduate Schools	Number Selected
Science	15	7
[Science Education, see comments (iii)]	-	-
Engineering	16	8
Total	31	15

Comments:

(i) Policy objective on concentration of resources for quality improvement was achieved.

(ii) In the guidelines for allocation of loan proceeds, no more than 15 subprojects for science and engineering graduate programs would be financed (para. 2.03 of SAR), and this was not exceeded.

(iii) For area of education at graduate level, the Korea National University of Teacher Education (KNUTE) was established in 1985 as center of excellence.

II. Strengthen the Research Content of Advanced Training

(a) From Loan Fund only:

	84	85	86	87	88	Total
No. of KOSEF Projects for Research Grants	61	216	234	517	324	1,352
Amount of Grant (Won million)	465	1,664	1,967	2,344	1,668	8,252

Comments: Through the component of KOSEF, the amount of research in terms of both project number and size of grant has been significantly increased, and the objective of strengthening research therefore achieved.

(b) From all sources (data for three years only were available):

Area	1986		1987		1988		Total	
	No. of Grants	Amount	No. of Grants	Amount	No. of Grants	Amount	No. of Grants	Amount
Science	343	1,424	10	265	28	774	381	2,463
Engineering	415	3,526	128	4,785	161	5,726	704	14,037
	758	4,950	138	5,050	189	6,500	1,085	16,500

Comments: It can be seen that the total funding for three years only is about twice as much as the amount of loan fund for KOSEF in five years. This shows that the Government is committed to the policy of strengthening research in Korea.

III. Raise Standards of College Programs in Science and Science Education:

(a) Expanding Laboratory Facilities (in Science and Technology at Undergraduate and Graduate Levels in Project Institutions.

	1984		1989		% of Increase	
	No. of Rooms	Area (m^2)	No of Rooms	Area (m^2)	(Rooms)	(Area)
Science Departments	587	53,240	1,121	95,084	91	79
Engineering Departments	968	86,038	1,281	114,886	32	34
Education Departments	199	19,497	223	21,637	12	11
Teacher's College	154	19,545	151	23,354	(-2)	19
Total	1,908	178,320	2,776	254,961	45	43

(b) Acquiring Experimental Equipment (in Science and Technology) at Undergraduate and Graduate Levels in Project Institutions.

		1984		1989		% Increase	
		No. of Items	Value (million won)	No. of items	Value (million won)	Items	Value
Science Departments	Q	22,685}		25,891}		14	
	I	8,126}	11,030	9,193}	37,835	13	243
Engineering Departments	Q	22,754}		30,566}		34	
	I	7,970}	21,259	11,944}	37,938	50	78
Education Departments	Q	9,732}		12,817}		32	
	I	2,142}	1,907	5,329}	6,480	149	239
Teacher's College	Q	7,943}		14,216}		79	
	I	2,073}	1,198	4,042}	2,335	95	95
Total	Q	62,114}		95,403		54	
	I	20,311}	35,394	36,468	84,588	80	139

Note: Q Stands for quantity and I, for item. For one item, the quantity may be more than one. Generally items increased more than the quantity.

Comments: (i) With this substantial increase in equipment, practical work should have improved.
(ii) In terms of value, the percentage increase is higher for science and education. However, these may not reflect the true status, as starting base may differ and was not available.

(c) Recruitment and Upgrading of Teaching Staff

(i) Quantitative Point of View

	1984			1989			% Increase (-for decrease)		
	Total Enrollment	No. of Teaching Staff	Student/ Teacher Ratio	Total Enrollment	No. of Teaching Staff	Student/ Teacher Ratio	Enrollment	Staff	S/T Ratio
Science Departments	43,087	1,279	34	58,386	1,844	32	36	44	-6
Engineering Departments	35,261	780	45	38,515	1,186	33	9	52	-27
Education Departments	8,632	259	33	5,480	308	18	-37	19	-45
Teacher's College	14,212	532	27	13,613	575	24	-4	8	-11
Total	101,192	2,850	35.5	115,994	3,913	29.6	15	37	-17

Comments: (a) The effort in recruitment of teaching staff is clear, but is still inadequate. However, the rate of its increase at 37% is higher than the rate of enrollment increase at 15%. This led to an improvement in the student/teacher ratio, although still falling short of hopes at the time of appraisal.

(b) Enrollment decreased in both education departments of universities and teacher's colleges (reflecting the decrease in demand for teachers). Their S/T ratios were comparatively low in 1984, and the decrease in enrollment makes it easier for further improvements in S/T ratios. The S/T ratios in 1989 at 18 for Education Departments and 24 for Teachers's Colleges are acceptable ratios.

(c) Enrollment in engineering programs increased by only 9 percent. This reflects the Government's policy of shifting from emphasis on quantity to emphasis on quality. The S/T ratio of 33 for engineering courses is still too high, but the 27 percent improvement in S/T ratio is significant and is in the right trend. Insistence on achieving the arbitrary figure of 20:1 by 1990 is both unreasonable and unrealistic.

(ii) Qualitative Point of View

(1) By Qualifications of Staff

Degrees Held by Faculties

	1984				1989				Change		
	Ph.D.	M.Sc.	Lower	Total/a	Ph.D.	M.Sc.	Lower	Total/a	Ph.D.	M.Sc.	Lower
Science Departments	651	443	39	1,183	1,338	381	28	1,747	+687	-112	-11
Engineering Departments	280	377	28	685	849	255	20	1,124	+569	-122	-8
Education Departments	145	147	19	311	256	79	8	343	+111	-68	-11
Teacher's Colleges	40	395	100	535	145	368	56	569	+105	-27	-44
Total	1,116	1,412	186	2,714	2,588	1,083	112	3,783	+1,472	-329	-74

/a Both figures in 1984 and 1989 in Table (c)(ii) differ from totals in Table (c)(i) above.

Comments: A clear increase of Ph.D.s and a decrease of both M.Scs. and lower degrees in all four categories. This is one important factor in the qualitative improvement of science and technology education.

(2) By Number of Publications (N.P.), Research Personnel (R.P.) and Research Funding (R.F)

	1984			1989			% of Changes		
	N.P.	R.P.	R.F. (million won)	N.P.	R.P.	R.F. (million won)	N.P.	R.P.	R.F.
Science Departments	931	1,062	25,138	1,205	1,418	44,779	29	34	78
Engineering Departments	721	523	15,580	1,365	812	60,023	89	55	285
Education Departments	332	317	2,975	414	374	6,070	25	18	104
Total	1,984	1,902	43,693	2,984	2,604	110,872	50	37	154

Comments: A clear case of improvement.

(d) Decreasing Average Teaching Load

Planned Goal for June 30, 1990	Achievements 1987	Achievement in 1990
10 hours per week	11 hours per week	Not Available

Comments: Although information from the PCR by MOE did not include the number of hours per week in 1990, it is estimated that the goal has been achieved. From Table (c)(i) above, it can be seen that the average S/T Ratio has been lowered by 17 percent based on a staff increase of 37 per cent and an enrollment increase of 15 percent. When the number of staff has increased at a much faster rate than the student enrollment, one obvious result is a decrease of teaching load and the use of the time spared for other purposes, which, most likely, is for research and publications (reference: Table (c)(ii)(2)).

IV. Improve Science Education at Secondary Level through a more experiment-oriented Science Curriculum

(a) Laboratory Improvement at High School Level

	1984 /a		1989		% Increase	
	No. of Rooms	Area (m^2)	No. of Rooms	Area (m^2)	(Rooms)	(Area)
In six cities	808	78,375	1,186	115,715	47	48
In nine provinces	1,164	94,115	1,600	131,508	37	40
Total	1,972	172,490	2,786	247,223	41	43

/a See next page.

(b) Equipment Improvement at High School Level

In nine provinces		1984 /a No. of items	1984 /a Value (million won)	1989 No. of items	1989 Value (million won)	% Increase (Items)	% Increase (Value)
In six cities	Q	372,249		1,192,927		220	
	I	9,067	2,479	15,620	11,855	72	378
In nine provinces	Q	1,390,135		2,116,082		52	
	I	45,145	13,552	78,356	19.233	74	42
Total	Q	1,762,384		3,309,009		88	94
	I	54,212	16,031	93,966	31,088	73	

/a Information was incomplete, e.g. no value for Seoul; no data for Taejon, data for which were included in Chungnam Province before Taejon was made a city.

Comments: (i) The data, while clearly showing improvements in both facilities and equipment, also show higher increase in the six cities. This should not be interpreted as discrimination against rural areas, because there is a migration from provinces into cities, thus increasing the demand for high schools in cities with increased population, and decreasing the demand in provinces.

(ii) The 88% increase in quantity and the 94% increase in value should have made an impact in science education at secondary level.

(c) Curriculum Improvement at High School Level

In 1987, the Ministry of Education (MOE) commissioned Korea Education Development Institute (KEDI) for a curriculum reform study. The overall reform period, including the related work of textbook revision, standard equipment list rewriting, in-service training and the implementation of the new curriculum, would extend to 1992. One of the result is more emphasis on science and experimentation in the new curriculum.

(d) Staff Improvement in High Schools

	1984	1989	% Changes
Enrollment	1,251,961	1,649,884	32%
Total Teaching Staff	52,658	73,787	40%
Student/Teacher Ratio	23.8	22.4	-6%
Science Teaching Staff	5,617	8,094	44%
Laboratory Assistant	46	543	1,080%

Comments: (1) Number of staff has made overall improvement of 40%, but number of science teaching staff has increased by 44%. Further, the number of laboratory assistants has increased nearly 12 times. These should also have made an impact on science education at secondary level.

(2) Further, 116,025 staff (including double and treble counts for receiving training again after an elapsed period) had received short duration in-service training in Korea during 1984-1988; and 2,076, outside Korea during same period.

(3) Hence staff improved both quantitatively and qualitatively.

Table 8(b): INSTITUTIONAL DEVELOPMENT

1. The Korea Council for University Education (KCUE) performed accreditation work continuously. (Reference Table 9 on Project Studies Report No. 4 by KCUE on Evaluation of Science and Engineering Education at Undergraduate and Graduate Levels in Korea.)

2. The Korea National University of Teacher Education (KNUTE) was established in 1985. Despite initial setbacks caused by a decreasing demand for teacher education, KNUTE had reached its full capacity of 2,000 in enrollment in 1989.

3. The Science Education Development Committee (SEDC) was established in MOE in October 1986. SEDC has contributed, inter alia, in systematic monitoring and evaluation of secondary science eduction (Reference Table 9 on Project Studies--Study Reports Nos. 5,7, and 9).

4. The Science and Technology Bureau was established within MOE in 1986. The Science and Technology Education Division was divided into two divisions: Science Education Division (SED) and Vocational Education Division. Staff in SED was increased to 16 from 9 instead of the planned figure of 15.

5. College entrance examination system was changed in 1988 and will be further changed in the early nineties.

Table 8(c): SOURCE OF FINANCING FOR PURCHASE OF EQUIPMENT IN THE AREA OF NATURAL SCIENCES
(The purpose of this table is to illustrate the direct benefit to private institutions, through an example in one area, i.e., Natural Sciences, as similar information for engineering and education collages had not been included in the PCR prepared by MOE).

Beneficiary	Equipment Purchased		Source of Financing			% Financing from Loan 2427-KO)
	Items	Amount (Won million)	IBRD	Government	Others	
			(Won million)			
16 National Universities	16,026	29,238	20,808 (US$26.8 million) (or 76% of Total	3,617	4,813	71%
18 Private Universities	35,615	13,515	6,583 (US$8.5 million) (or 24% of Total)	86	6,846	49%
Total	51,641	42,753	27,391 (US$35.3 million)	3,703	11,659	64%

Comments: (1) According to the guidelines on allocation of Loan Proceeds, about 30% should be for private universities. The 24% achieved is therefore satisfactory in light of the effort made in 1985 through a Supplemental Letter for amendments on the guidelines for the purpose of increasing private institution participation. The lack of success of this effort was partly caused by the Government's introduction of an equipment leasing system at that time, as a result of which, the private institutions had one more option than borrowing from the Government.

(2) Private Universities obtained 51% of financing from Government and others (mostly others) and only 49% from IBRD. This showed that private institutions, unlike national universities, did enjoy significant financing from other sources.

Table 9: PROJECT STUDIES

Title of Study	Date of Report	Status	Impact
1. Improvement of High-Quality Manpower Supplying System in Areas of Advanced Science and Technology.	December, 1985	Completed	Used for manpower planning.
2. Optimum Standard Lists of Laboratory and Practical Equipment for Higher Education.	March, 1986	Completed	Served the purpose for equipment planning and procurement.
3. The Expansion Plan of Research Facilities in Graduate Education.	April, 1986	Completed	Used by Graduate Schools and University Education Office of MOE.
4. Evaluation of Science and Engineering Education at Undergraduate and Graduate Levels in Korea.	September, 1986	Completed	Used by University Education Office of MOE.
5. Development of Improvement Plans and Monitoring Systems based on the Status Survey of High School Science Education.	December, 1986	Completed	Used by Bureau of Elementary and Secondary Education of MOE.
6. Mid-term Evaluation of the 6th IBRD Education Sector Loan.	October, 1987	Completed	Served as basis for the Bank/Borrower joint mid-term review.
7. Development of Improvement Plans and Monitoring System based on the Status Survey of Secondary Science Education.	December, 1987	Completed	An up-date of the 1986 Report.

8.	Effective Acquisition of Educational Equipment, Inventory Management System and Cooperative Utilization.	December, 1987	Completed	Used by MOE.
9.	Development of Improvement Plans and Monitoring System based on the Status Survey of School Science Education.	December, 1988	Completed	An up-date of the 1987 Report.
10.	Mid- and Long-term Improvement Plans for Acquisition of Educational Research Equipment in Colleges.	March, 1989	Completed	Used by University Education Office of MOE.

Comments: The Studies formed a sound base for policy dialogue within the Government and arising from such dialogue, four concrete recommendations were proposed:

a) The need to expand graduate education;

b) The need to establish university affiliated research institutes (This became one component, "Joint Research Facilities", of the recent Universities Science and Technology Research Project under Loan 3203-KO.);

c) The need to develop associated programs to support a) and b) above; and

d) the need to strengthen the financial status of the private and regional universities as well as to insure their sustainability. (In Loan 3203-KO, about 20% of loan proceeds would be allocated to private universities, at least 30% to regional universities for graduate schools of science and engineering and joint research facilities and at least 50% to regional universities for schools of science education).

G. STATUS OF LOAN COVENANTS

Table 10: COMPLIANCE WITH LOAN COVENANTS

Section No. in Loan Agreement	Paragraph No. in SAR	Description	Status of Compliance and Deadline Dates, if applicable
3.05	3.11	Finance Sub-projects in accordance with guidelines and criteria satisfactory to the Bank.	No deadline date and in full compliance. Eligibility criteria agreed to be relaxed by Bank in letter dated 5/14/85.
3.06	3.11	Select National Programs in accordance and criteria satisfactory to Bank.	No deadline date and in full compliance.
3.07	2.07 and 2.14	Award fellowship in accordance with selection criteria and procedures satisfactory to the Bank.	No deadline date and in full compliance.
3.08(a)	2.18	Review progress annually and jointly with the Bank on the Action Plan and indicators.	In full compliance.
3.08(b)	4.09	Prepare annually a financial plan for private graduate schools, colleges and high schools to ensure their quality improvements.	In full compliance.

Section No. in Loan Agreement	Paragraph No. in SAR	Description	Status of Compliance and Deadline Dates, if applicable
3.08(c)	3.14	Hold mid-term review on progress achieved.	Not later than October 31, 1987. Held in November/December 1987.
4.02(c)	4.15	Furnish annually audit reports on project accounts and a separate auditor's opinion on statements of expenditures.	By June 30 of each year. Submitted annually but after the deadline date.
3.04(d)	4.15	Submit to the Bank a project completion report.	Not later than six months after the Closing Date of the Loan. Instead of submitting a project completion report for the Loan, the borrower submitted three reports, one for each project institution, (MOE, KAIST and KOSEF). KOSEF submitted the report on 6/30/90, six months later than deadline date.

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Action Program on Sector Policies and Institutional Development: 1984-90

Objectives/Strategies	Actions Taken by April 15, 1984	Compliance with Planned Action Program at mid-term review	Actions Taken by Closing Date June 30, 1989
1. Graduate Training and Research: To develop graduate programs in the sector and to increase funding for, improve the management of and raise the quality of corresponding research activities.			
(a) Control quality of graduate programs in science and engineering by means of graduate program accreditation.	Government has assisted in the creation of the KCUE, an association of all colleges and universities in Korea. The Council seeks to promote quality education by conducting reviews and evaluations of higher education and recommending appropriate policies. Steps were initiated for graduate program accreditation under the aegis of the new KCUE. Program evaluation at KAIST would be conducted by an external visiting committee.	KCUE was assigned the task for undertaking accreditation on 9/16/86 with a cost of won 24,866,000 for one year. Models were developed in October, 1986. Questionnaires were developed in December, 1986 distributed thereafter and collected in March 1987. Results were analyzed and computerized in May 1988. Field visits were made in June 1988. Report was submitted in September 1988.	KCUE was evaluating quality of higher education in universities and colleges continuously. Evaluation of KAIST programs by an external visiting committee had not been carried out. Reasons were not clear.
(b) Concentrate resources for graduate education in the sciences and in engineering in fewer institutions, with increased specialization among institutions to be reflected in the investment plan for facilities and equipment.	Government has decided to designate selected graduate-oriented universities for science and engineering fields. Guidelines and eligibility criteria for subloans and assistance under national program for graduate school were received by Bank staff and are acceptable to the Bank.	A report on the long-term development plan for graduate education was submitted in July 1988. (Not a Study financed from the Project, thus not in Table 9: PROJECT STUDIES). Thirty-one (31) subprojects on graduate education (15 for science and 16 for engineering) had been appraised and 15 were approved (7 for science and 8 for engineering). Although 10 were suggested originally on grounds of concentration of resources "no more than 15" was stipulated in the guidelines for Allocation of Loan Funds, so 15 was not considered to be excessive. The goal on concentration of resources was therefore achieved. Out of the 15, only two were from Seoul, the other 13 were all regional institutions. The objective of regional distribution of loan funds (at least 30% would be allocated to institutions outside the Seoul area) was therefore also achieved.	No further action was necessary The 15 subprojects were satisfactorily implemented.
(c) Strengthen the key institution for promotion and funding of research in support of national science and technology goals.	KOSEF prepared a development plan to expand support of academic research in science and technology. KOSEF has reviewed priority fields in relation to the MOST plan for science and technology development. KOSEF prepared an investment plan for academic research support indicating proposed allocations to priority fields and also developed a plan for strengthening KOSEF management. Bank staff reviewed the investment plan and the plan for strengthening KOSEF management and found both plans reasonable.	An example for 1986 on Research Grants distributed by KOSEF was: (a) 59% to basic and applied sciences, and 42% to engineering fields by fund; and (b) 57% and 43% respectively by number of projects. These were close to the 60% and 40% envisaged. Staff increase was achieved. The target of 45 by 1988 has already been exceeded, as the number has reached 50.	Total number of grants in three years between 1986 and 1988 was 1,085, of which 381 (35%) were for science and 704 (65%) for engineering projects. Total amount of grants was 18,800 million won or US$21.2 million (according to average exchange rate in this period, 777.14 won to US$1.00) of which 2,463 (13%) were for science and 14,087 (88%), for engineering. The total amount of grants exceeded the amount of loan fund for KOSEF, because Government and endowments were also sources of funding. Compared with 1987 report, the trend was a shift of emphasis from science to engineering. Reasons were not clear, but clearly there was a change in KOSEF's plan. Staff increase was more than achieved (see note under column for mid-term review.).

Objectives/Strategies	Actions Taken by April 15, 1984	Compliance with Planned Action Program at mid-term review	Actions Taken by Closing Date June 30, 1989
(d) Improve collaboration among graduate schools and research institutes by cooperation in graduate teaching and in joint research.	MOST has budgeted for research collaboration with universities and with private industry. MOST has formally instructed major research institutes to appoint training coordinators from among the research personnel to organize and supervise assistance to graduate students from universities who would undertake dissertation research at research institutes. Among research institutes, KAIST, in particular, serves as a major center for university faculty development. KAIST is also conducting part-time graduate programs for approximately 400 scientists and engineers in the institutes.	KAIST was implementing its plan for expansion of graduate education, especially at the Ph.D level.	See attachment to Annex 1.
(e) Develop within the network of colleges of education, a specialized center for graduate training and for research and development in science education.	The Government decided to establish the Korean National University of Teacher Education for commencement of operation in March 1985. Bank staff reviewed proposals for graduate training and research in science education. Bank staff agreed to include under subprojects an allocation for graduate training in science education, subject to preparation of detailed loan application.	The Korea National University of Teacher Education (KNUTE) was established in March 1985 as planned.	KNUTE encountered initial difficulties in being unable to reach its full enrollment capacity of 2,000 in 1988 due to decreasing demand of teachers in the job market. The situation improved and the full capacity had been reached in 1989 only one year behind "planned".
2. <u>College-Level Science Education: To increase the number and raise the qualifications of teaching faculty and to improve facilities and equipment in colleges of natural science and science education departments in colleges of education.</u>			
(a) Control quality of science programs by means of a college of natural science accreditation.	See Section 1(a).	See Section 1(a).	See Section 1(a).
(b) Increase number and upgrade qualifications of faculty members in colleges of education and colleges of natural science. Continue recruitment program for faculty of colleges of engineering.	Government has prepared faculty development and faculty recruitment plans for colleges of education, colleges of natural science and colleges of engineering. National program for faculty development and recruitment were designed and costed. Bank staff reviewed the plans and found them reasonable.	Recruitment and upgrading of staff in progress.	See Table 8.
(c) Prepare an improvement plan for facilities and equipment.	Government has prepared revised equipment lists by subject area. Equipment for colleges of education is primarily for science education and science teaching. An investment plan based on updated survey of requirements was reviewed by Bank staff and found reasonable. Guidelines and eligibility criteria were agreed for purposes of processing subloans.	Facilities improvement and equipment procurement in progress.	See Table 8.
3. <u>Secondary Science Education: To increase the study of science subjects, particularly at the high school level; to improve curricula and instructional materials; to strengthen the skills of classroom teachers; and to upgrade facilities and equipment of general high schools and regional science centers.</u>			

Objectives/Strategies	Actions Taken by April 15, 1984	Compliance with Planned Action Program at mid-term review	Actions Taken by Closing Date June 30, 1989
(a) Design and implement new science curriculum with greater emphasis on experimental and practical science work and establish a management agency to oversee and coordinate overall implementation.	Government has adopted a plan to offer high school science courses on both the ordinary and the advanced levels, with science requirement for all students and prepared syllabi for new courses to be introduced in 1984. New courses would devote about 20% of instructional time in science to experimental work. Bank staff reviewed the plan for improvement of secondary science curriculum. Bank staff and Government agreed on the creation of the Science Education Development Committee (SEDC) to oversee planning and implementation of disparate functions of curriculum design, materials preparation, teacher retraining, evaluation and feedback and on staff strengthening of the Science and Vocational Education Division of CEB.	Science Education Development Committee (SEDC) was established in MOE in October 1986. The Science and Technology Bureau (STB) was also established within MOE in 1986. The Science and Technology Education Division under the General Education Bureau before was divided into two divisions under STB, namely the Science Education Division and the Vocational Education Division. The MOE reorganization, together with the newly established SEDC, enabled further strengthening of science education in the education system.	New curriculum had been introduced for all high schools with more emphasis on science and experimentation. Facilities and equipment had been improved. Number of staff, especially science teaching staff, had been increased and in-service training had been provided. Number of Laboratory assistants had been significantly increased, but the goal of two per school had not been achieved yet. Development and progress had been closely monitored by SEDC and STB of MOE.
(b) Introduce systematic monitoring of secondary science education for policy analysis.	Government and the Bank have agreed on two areas that require further study. These are the need for: national surveys to evaluate student performance for policy guidance; and improvement of assessment skills by teachers.	Studies were in progress.	Four studies had been completed (Reference: Table 9, Study Report Nos. 5, 7, 8 and 9). The Study Reports Nos. 5, 7 and 9 were for Development of Improvement Plans and Monitoring Systems based on Status Survey of High School Education and were used first by the Bureau of Elementary and Secondary Education of MOE and later also by the new Science and Technology Bureau. Report No. 8 was for improvement of equipment management and was used by MOE, including Bureau for High School Education.
(c) Adjust college admissions procedures to enable individual colleges to select students by taking account of student's overall performance on the entrance examination, as well as achievement on the science and mathematics component of the entrance examination and on the school record.	Since 1981 college admission procedures have taken into account the school record and the school record includes a grade for experimental and practical work. In most cases, however, only a total score is made available to colleges and decisions on admission to programs in science or engineering are made without detailed information on student prior achievement in science and mathematics. The effects of the changes to date are insufficient as an incentive for schools, teachers and students to place more emphasis on sciences. The school record and the science record component are not systematically shared with colleges selecting students.	Preparation work for changes in the college admission system was in progress.	The college admission examination system was changed in 1988. The system of having examinations before application was reversed to have application before examination to enable more direct participation of universities/colleges in the system of selecting their new entrants. The dependence only on examination result was also changed to take into account high school achievements including science laboratory performance and interviews. The system will be further modified in about 1993 through the use of aptitude tests.
(d) Design and implement staff development programs for secondary science teachers, laboratory assistants and science education specialists in regional science centers, and central agencies of MOE.	MOE prepared a national program for retraining and upgrading secondary science teachers and specialists including overseas training in fields not currently offered in colleges in Korea. Bank staff reviewed the national program and found it reasonable.	In-service and overseas training was in progress.	Completed in-service short duration training for 116,025 staff (including double and treble counts, as the same staff could have attended several courses in consecutive years). Completed overseas training for 2,075 staff. Both were achieved between 1984 and 1988.

Objectives/Strategies	Actions Taken by April 15, 1984	Compliance with Planned Action Program at mid-term review	Actions Taken by Closing Date June 30, 1989
4. Science and Technology Education Sector Planning and Finance.			
(a) Improved manpower monitoring for science and technology sector.	EPB chairs a manpower promotion committee with authority to coordinate manpower planning to formulate and commission special studies. Government regularly updates manpower projections as well as relevant labor market information, using resources of MOST, Ministry of Labor, MOE, EPB and consultants in Korea Development Institute and KEDI.	The Study Report on "Improvement of High Quality Manpower Supplying System in Areas of Advanced Science and Technology" was completed in December 1985 and was used for manpower planning. The admission quota system was changed to a graduate quota system, but the result was not significant in reducing growth rates.	A continuing manpower monitoring for science and technology sector was in progress. Sources of information were from several agencies, including Ministry of Labor, MOST, MOE, EPB, KDI and KEDI. An example of the effect of the system is the control of engineering course enrollments and keeping its growth at only 9% between 1984 and 1989 (Reference: Table 8(a) III(c)) compared to the admission quota increases of 30% each year in 1980 and 1981.
(b) Projected enrollment in undergraduate and graduate programs in science and engineering should not exceed economically justifiable level or increase at such a pace as to prejudice goal of improving quality.	MOE and MOST have prepared enrollment and output forecasts through 1990 in science and engineering programs as indicative annual enrollment levels. Bank staff reviewed enrollment and output in relation to investment plan and various estimate of demand prepared by MOST. On the graduate level there is an approximate balance. On the undergraduate level, projected output in engineering may exceed the forecast of economic demand. This is due to high social demand, rapid expansion of enrollment in the period 1980-82 and Government decisions to promote training of science and technology manpower.	See 4(a) above.	So 4(a) above. The priority accorded to vocational high school (VHS) graduates to be admitted in college engineering programs was abolished and this had the direct effect of reducing the social demand for VHS admission and then the indirect effect on college engineering programs due to less applicants from the VHS system. The lower growth in engineering courses permitted: (a) a faster improvement in student/teacher ratios in the late eighties than in the early eighties and (b) quality improvement.
(c) Based on a sector survey carried out jointly by Government and the Bank in 1981 and 1982, several adjustments were recommended in education plans. Overall spending on education should be adjusted in accordance with economic performance and annual budgetary policy. In order to diminish impact on recurrent expenditure of proposals in Fifth Five-year Plan (FFYP) to reduce class size, raise teachers' salaries and implement compulsory middle school education, Government should phase implementation over a ten-year as opposed to a five-year period.	Government agreed that original policies to reduce class size and achieve universal publicly funded middle school education would be achieved by 1991 rather than by 1986 as was initially proposed. Government also prepared a revised analysis of projected educational expenditure and finance in Korea. Bank staff reviewed the information and concluded that the overall trend is consistent with targets under the FFYP, including revenue from the education tax. Expenditure by MOE will not exceed 22% of national budget or 4.1% of GNP during the FFYP and should decline marginally to 1991. In 1982, total public expenditure on education and training reached approximately 6% of GNP, and total private finance of education and training was about 3.9% of GNP. These levels are reasonable.	"No further action required" was recorded in the Action Program in the SAR (Annex 1 of SAR, Report No. 4891-KO dated May 1, 1984).	-

Objectives/Strategies	Actions Taken by April 15, 1984	Compliance with Planned Action Program at mid-term review	Actions Taken by Closing Date June 30, 1989
(d) Korea has developed a large privately funded education system that fulfills a valuable educational role at both the secondary and higher levels. It operates under close supervision of Government, including Government regulation of fees, and provides educational services in both urban and rural areas. It effectively expands educational opportunity without social bias. However, private schools and colleges require financial assistance for improvement of science and technology education. Private graduate schools, in particular, require additional financial assistance for expansion and improvement of graduate programs.	Government recognizes that private educational institutions provide valuable public service and reduce the share of educational finance borne by the Government. It is in the public interest to preserve their financial base and to assist their achieving quality objectives. Bank staff reviewed the level of fees in both public and private institutions and judged them as adequate and reasonable. Government agreed to review fees annually and, if necessary, increase them.	The number of applications for financial assistance from private institutions was satisfactory for undergraduate program, but unsatisfactory for graduate programs. This led to the Supplemental Letter amendment of the eligibility criteria in 1985, but the improvement was still insignificant. The Government prepared annually a financial plan for private institutions to ensure their quality improvement.	Loan proceeds were channeled to private institutions (Reference: Table B(c)). The achievement (24%) was slightly below planned (about 30%). However, the 18 private institutions receiving loan proceeds had about 51% of their financing from sources other than IBRD during 1984 and 1989 compared to 20% for the 16 national universities. This indicated that the slightly low achievement versus planned should not create a serious issue due to the availability of other sources of financing.

ANNEX I
Attachment

KAIST achieved the following in its expansion plan:

	1986	1990	% Increase	Remarks
Intake into Master's Program	531	800	51%	
Intake into Doctoral Programs	271	380	40%	
Output from Master's Program	351	500	42%	
Output from Doctoral Program	55	150	172%	Objectives for Ph.D. programs were achieved

	1984	1988	% Increase	
No. of Professors	119	158	35%	
No. of Theses Published	346	601	74%	Shows qualitative improvement
Amount of Research Funding	272 /a	611 /a	124%	

	1986	1990	% Increase	
No. of students in Masters Program	1,135	1,399	23%	Objective of emphasis on Ph.D. programs was achieved.
No. of students in Doctorate Program	891	1,594	79%	
Total	2,026	2,993	48%	
No. of Professors	143	230	46%	
Student/Professor Ratio	14:1	13:1		Improved

Despite expansion, employment rates of graduates was always close to 100%.

The increased supply of graduates with quality Ph.D. and masters degrees improves the supply and qualifications of staff in the areas of science and technology in higher education.

/a Million won.

ANNEX 2

KOREA

PROJECT COMPLETION REPORT

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Participants in Completion Mission

World Bank

Sing-Zak Sung, Consultant Technical Educator

Ministry of Education

Chung, Bong Gun, Director ELPD

Korea Advanced Institute of Science and Technology

Jang Jai Joong, Director, International Relations Office

Korea Science and Engineering Foundation

Chung Byong Ock, Director, International Relations Office

KOREA

PROJECT COMPLETION REPORT

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Record of Progress Reports Submitted

1. Progress Report on Korea Science and Technology Education Loan, KOSEF, February 1985.

2. Report on the Progress and Status of IBRD Loan Project Implementation and Projection for 1985, KAIST, September 1985.

3. Report on the Progress and Status of IBRD Loan Project Implementation and Projection for 1985, KAIST, November 1985.

4. Progress Report of the Second Education Loan Project, EFB/MOE, November 20, 1985.

5. Progress of the Second Education Sector Loan Project, MOE, April 1986.

6. Progress Report on Korea Science and Technology Education Loan, KOSEF, April 1986.

7. Plan for the Effective Implementation of KOSEF Activities, KOSEF, July 1986.

8. Financial Support to Private Institutions, MOE, October 1986.

9. Progress Report on the Korea Science and Technology Loan, KOSEF, October 1986.

10. Report on the Progress and Status of IBRD Loan Project Implementation, KAIST, October 1986.

11. Progress of the Second Education Sector Loan Project, ELPD/MOE, October 1986.

12. Progress of the Second Education Sector Loan Project, ELPD/MOE, May 1987.

13. Progress Report on Korea Science and Technology Education Loan, KOSEF, May 1987.

14. Report on the Progress and Status of IBRD Loan Project Implementation, KAIST, June 1987.

15. Progress Report on Korea Science and Technology Education Loan, KAIST, October 1987.

16. Mid-Term Review Report on the Sixth IBRD Education Sector Loan Project, Mid-Term Review Team, October 1987.

17. Report on the Progress and Status of IBRD Loan Project Implementation, KAIST, November 1987.

18. Progress Report on Korea Science and Technology Loan, KOSEF, May 1988.

19. Report on the Progress and Status of IBRD Loan Project Implementation, KAIST, May 1988.

20. Progress Report on the Science and Technology Loan Project, MOE, May 31, 1988.

21. Progress Report on the Korea Science and Technology Loan, KOSEF, October 1988.

22. Progress Report, KAIST, October 1988.

23. Progress of the Second Education Sector Loan Project, ELPD/MOE, October 1988.

24. Progress Report on Korea Science and Technology Education Loan, KOSEF, March 1989.

25. Progress of the Second Education Sector Loan Project ELPD/MOE, March 1989.

26. Status of IBRD Loan Implementation, KAIST, March 1989.

H. USE OF BANK RESOURCES

Table 11: STAFF INPUTS BY STAGE OF PROJECT CYCLE IN STAFF WEEKS

Stage of Project Cycle	Planned		Revised		Final	
	HQ	Field	HQ	Field	HQ	Field
Through Appraisal	50	-	40	24	37.8	25.9
Appraisal - Negotiations	50	-	-	-	30.7	21.6
Negotiations - Loan Signing	16	-	-	-	17.8	-
Supervision	45	-	-	-	25.5	17.5
PCR	8	-	-	-	5.0	0.6
Others (Project Admin.)	3	-	-	-	2.7	-
Total	172					185.1

Comments: The total staff input up to Loan Signing was 133.8 staff weeks and the total thereafter, 51.3. The high figure at upstream and the low figure after loan signing verifies the usual understanding that for a sector loan, more staff work before loan signing pays a dividend for lower staff work later.

Table 12: MISSION DATA BY STAGES OF PROJECT

Mission	Month/Year	No. of Persons /a	Staff Weeks in Field	Performance Status by Activity /b				
					F	M	I	G
Identification	11/81	2(E,A)	6.0					
Preparation (by Gov't)	12/81-2/82	-	-					
Pre-appraisal	3-4/82	5(A,E,GE,GE,GE)	17.5					
Preparation	6-7/83	2(E,TE)	2.4					
Appraisal	9-10/83	6(E,TE,GE,GE,A,,YP)	21.0					
Post-appraisal	2/84	1(E)	0.6					
Subtotal			47.5					
Supervision I	9/84	1(E)	1.1		2	1	1	1
Supervision II	11/84	1(TE)	1.0		1	1	1	1
Supervision III	4/85	3(E,TE,E)	3.0		1	1	1	1
Supervision IV	11/85	2(E,GE)	1.4		1	2	1	1
Supervision V	4/86	2(E,TE)	1.2		1	2	1	1
Supervision VI	10/86	1(TE)	1.0		1	2	1	1
Supervision VII	5-6/87	2(EP,TE)	2.8		1	2	1	1
Supervision VIII	11-12/87	2(PE, TE)	3.8		1		1	1
Supervision IX	5-6/88	2(PE,TE)	1.2		1		1	1
Supervision X	10/88	1(TE)	1.0		1	1	1	1
Subtotal			17.5	Average	1.1	1.4	1.0	1.0
PCR	3/89	1(TE)	0.6					
TOTAL			65.6					

/a E = Economist; A = Architect; GE = General Educator; TE = Technical Educator; YP = Young Professional; EP = Education Planner; PE = Principal Economist.
/b F = Financial; M = Managerial; I = Development Impact, G = Overall Status.